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COLORADO POTATO BEETLE



a, Adult beetle; b, eggs; c, larvae (or slugs); d, pupa (or resting stage). (a, c, and d about natural size; b about twice natural size.)

(See other side for life history and control)

COLORADO POTATO BEETLE

(*Leptinotarsa decemlineata* Say)

Life History

The eggs of the Colorado potato beetle are laid on the under side of the leaves. These eggs hatch in from 4 to 9 days. The resulting larvae (or slugs) feed on the plant. The larva grows rapidly, passing through four stages, or instars, similar in appearance except that each stage is larger than the preceding one. It becomes full grown in 10 days to 3 weeks after hatching from the egg. The full-grown larva then burrows into the ground and changes to a pupa, or resting stage. After 5 to 10 days the adult beetle emerges from the pupa, crawls up out of the ground, and, after feeding on the plants for a few days, may lay eggs for another brood of larvae.

Control

Dust the foliage thoroughly with a 3-percent DDT dust.

Sprays are also effective if applied with a good sprayer throwing a fine mist. Use 2 level tablespoonfuls of 50-percent DDT wettable powder or 2 level teaspoonfuls of 25-percent DDT emulsion concentrate per gallon of water. To make 100 gallons of spray use either 3 pounds of the 50-percent wettable powder or 2 pounds of the 25-percent DDT emulsion concentrate. If sprays are to be used for disease control, either of these DDT preparations may be added to the fungicidal spray rather than to water, and both materials applied with one operation.

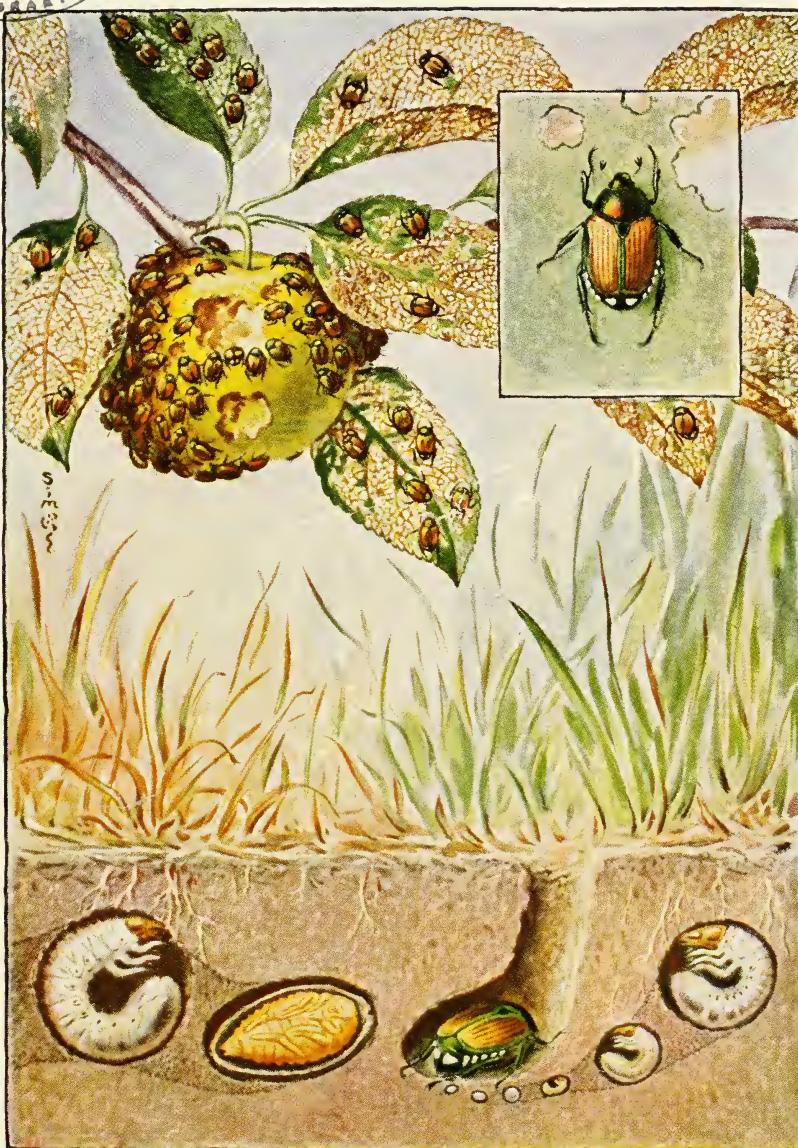
Begin spraying or dusting when the beetles first appear. Spray or dust for the slugs when eggs are hatching, and repeat the treatment as often as necessary.

Caution.—Insecticides are poisonous and should be handled with care. Store in a dry place where children and animals will not have access to them.

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JAPANESE BEETLE



Adult beetles feeding on fruit and leaves, about one-half natural size.
Insert, adult beetle, about twice natural size. Figures below ground represent seasonal history of the Japanese beetle. Left to right, mature grub (late spring); pupa; beetle laying eggs (summer); developing grubs (late summer and fall); all about twice natural size.

(See other side for life history and control)

JAPANESE BEETLE

(*Popillia japonica* Newman)

Life History

Japanese beetles spend about 10 months of the year as grubs in the soil, feeding on the roots of grasses and other plants. Early in June the grubs stop feeding and go through a resting, or pupal, stage, at the end of which they become beetles. By the first part of July the beetles are flying about in numbers and feeding extensively on the foliage, fruit, and blossoms of many trees and plants. During July and August the females go into the ground and lay eggs which hatch into small grubs. Grubs are usually more abundant in turf than in other situations.

Control of the Beetle

The foliage of trees, shrubs, and flowering plants can be protected from beetle attack by spraying or dusting. The most useful sprays are as follows:

1. DDT (50-percent wettable powder), 3 ounces (16 tablespoonfuls); water, 10 gallons (for fruit and shade trees, shrubs, and flowering plants).
2. Lead arsenate, 10 ounces (30 tablespoonfuls); wheat flour, 6 ounces (24 tablespoonfuls), or light-pressed fish oil, 2½ fluid ounces (5 tablespoonfuls); water, 10 gallons (for shade trees and shrubs).
3. Powdered derris (4-percent rotenone), 5 ounces (30 tablespoonfuls); water, 10 gallons (for apple, plum, cherry, and peach trees, grapes, and small fruits when fruit is about to ripen, and flowering plants).

Where spraying equipment is not available, apply a 5-percent DDT dust or hydrated dusting lime.

Apply the spray or dust when the beetles first appear. Repeat as needed to maintain a protective coating on all parts of the plant subject to attack, until the beetles disappear. Dusts must be applied more often than sprays.

Control of Grubs

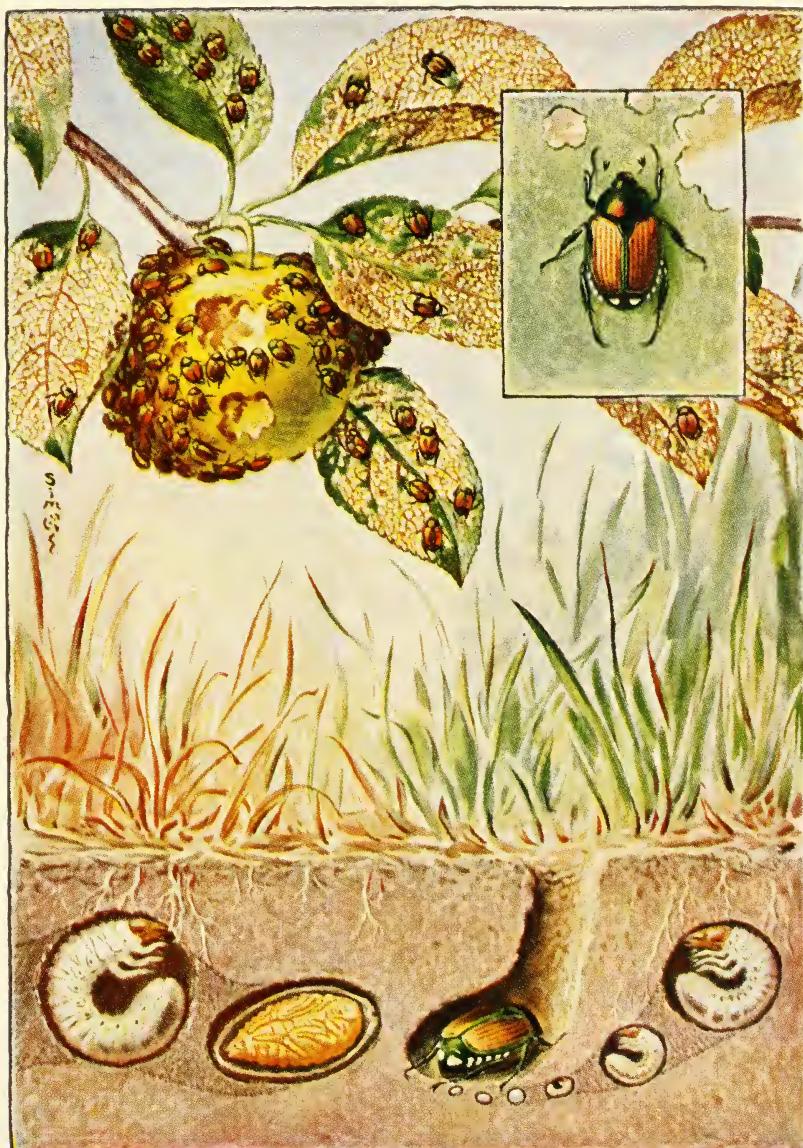
Use of Poisons.—Lawns may be protected from injury by Japanese beetle grubs for at least 4 years with one application of either DDT or lead arsenate. Use 6 pounds of a 10-percent DDT powder or 10 pounds of lead arsenate to each 1,000 square feet of lawn area. Mix the material with several times its volume of slightly moist sand, soil, or other suitable material, and apply evenly to the lawn with a garden-type fertilizer distributor or by hand. Wash the material in with a hose.

Use of Milky Disease.—Japanese beetle grubs are subject to a number of diseases, the most important of which is the milky disease. Several dust mixtures containing spores of the organism causing this disease are available commercially. They are preferably applied by community groups, but may be used by individuals. Directions are on the package. The disease usually works slowly, and its full effect may not be evident for several years. Although it kills grubs in the soil, it does not prevent beetles from flying in from untreated areas. It is harmless to all other forms of plant and animal life.

PRECAUTIONS IN USING DDT AND LEAD ARSENATE

DDT and lead arsenate are poisons, but when used as recommended are not likely to injure human beings, pets, wildlife, or vegetation. Avoid inhaling the dust. Protect the hands with leather or rubber gloves. Keep the hands away from the mouth and wash them thoroughly before eating. Do not spray fruits with DDT later than 2 weeks before picking. Wash sprayed or dusted fruits or vegetables before eating them. Keep the poison in plainly labeled closed containers away from food products, and where children or pets cannot reach them. Keep small children and domestic animals away from poisoned turf until it has been watered or rain has fallen.

JAPANESE BEETLE



Adult beetles feeding on fruit and leaves, about one-half natural size.
Insert, adult beetle, about twice natural size. Figures below ground represent seasonal history of the Japanese beetle. Left to right, mature grub (late spring); pupa; beetle laying eggs (summer); developing grubs (late summer and fall); all about twice natural size.

(See other side for life history and control)

JAPANESE BEETLE

(*Popillia japonica* Newman)

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Japanese beetles spend about 10 months of the year as grubs in the soil, feeding on the roots of grasses and other plants. Early in June the grubs stop feeding and go through a resting, or pupal, stage, before they become beetles. By the first part of July the beetles are flying about in numbers and feeding extensively on the foliage, fruit, and blossoms of many trees and other plants. In July and August the females go into the ground and lay eggs, which hatch into small grubs. Grubs are usually most abundant in turf.

Control of Beetles

Plants can be protected from beetle attack with the following sprays:

1. DDT (50-percent wettable powder), 3 ounces (20 tablespoonfuls); water, 10 gallons (for fruit and shade trees, shrubs, and flowering plants).
2. Lead arsenate, 10 ounces (30 tablespoonfuls); wheat flour, 6 ounces (24 tablespoonfuls), or light-pressed fish oil, 2½ fluid ounces (5 tablespoonfuls); water, 10 gallons (for shade trees and shrubs).
3. Powdered derris 4-percent rotenone), 5 ounces (30 tablespoonfuls); water, 10 gallons (for apple, plum, cherry, and peach trees, grapes, and small fruits when fruit is about to ripen, and flowering plants).

Where spraying equipment is not available, apply a 5-percent DDT dust or hydrated dusting lime.

Apply the spray or dust when the beetles first appear. Repeat as needed to maintain a protective coating on all parts of the plant subject to attack, until the beetles disappear. Dusts must be applied more often than sprays.

Control of Grubs

Use of Poisons.—Lawns may be protected from injury by Japanese beetle grubs for at least 6 years with one application of DDT and for at least 3 years with one application of chlordane. Use 6 pounds of a 10-percent DDT powder or 2¼ pounds of a 10-percent chlordane powder to each 1,000 square feet of lawn. Mix the material with several times its volume of slightly moist sand, soil, or other suitable material, and apply evenly to the lawn with a garden-type fertilizer distributor or by hand. Wash the material in with a hose.

Use of Milky Disease.—Japanese beetle grubs are subject to a number of diseases, the most important of which is the milky disease. Several dust mixtures containing spores of the organism causing this disease are available commercially. They are preferably applied by community groups, but may be used by individuals. Directions are on the package. The disease usually works slowly, and its full effect may not be evident for several years. Although it kills grubs in the soil, it does not prevent beetles from flying in from untreated areas. It is harmless to all other forms of plant and animal life.

PRECAUTIONS.—DDT, chlordane, and lead arsenate are poisons, but when used as recommended are not likely to injure human beings, pets, wildlife, or vegetation. Avoid inhaling the dust. Protect the hands with leather or rubber gloves. Keep the hands away from the mouth and wash them thoroughly before eating. Do not spray fruits with DDT later than 4 weeks before picking. Wash or peel sprayed or dusted fruits or vegetables before eating them. Keep the poison in plainly labeled closed containers away from food products, and where children or pets cannot reach them. Keep small children and domestic animals away from poisoned turf until it has been watered or rain has fallen.

October 1950

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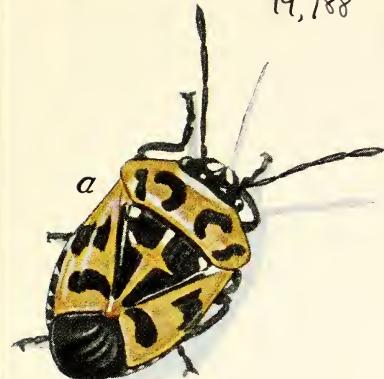
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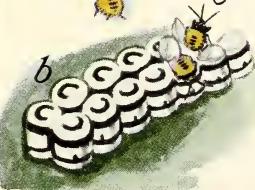
HARLEQUIN BUG



d



c



MARY F. BENSON

a, Adult; b, eggs; c to g, young, or nymphs; h, damaged cabbage leaf with nymphs, adult bug, and eggs. (a and c to g about 3 times natural size; b about 4 times natural size, h about natural size.)

(See other side for life history and control)

HARLEQUIN BUG

(*Murgantia histrionica* Hahn)

Life History

The harlequin bug is a southern plant pest and lives through the winter in the adult stage near fields where its food plants are grown. The bugs leave their winter quarters early in the spring and seek their favorite food plants, which are cabbage, collard, turnip, horseradish, kale, and related crops. The increase in population is started by the eggs, which are laid on the under side of the leaves. These eggs hatch in from 4 to 15 days, and the young, or nymphs, feed and develop on the leaves of the plants, sucking the sap from the leaves and stems. Shortly afterward white areas or blotches appear about the spots where the feeding has occurred, and the injury often causes the plants to wither and die. The insect becomes full-grown in from 40 to 50 days after hatching from the egg. The adult, or winged stage, is reached after the nymphs have passed through five immature stages, or instars. Within 2 or 3 weeks after becoming full-grown the female is ready to deposit eggs for another brood.

Control

Practice clean cultural methods throughout the season. Disk and plow under all stalks and other refuse as soon as the crop has been harvested. The growing of trap crops, hand picking, and the use of the blow torch are also effective methods of keeping down the number of bugs.

Control by insecticides is recommended only after preventive measures to reduce the numbers of the insect have been followed.

Spray or dust with derris or cube.

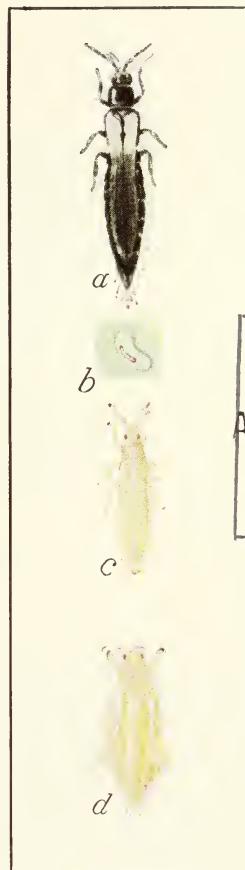
Use 1½ pounds of derris or cube root powder (containing 4 percent of rotenone) with a spreader and wetting agent in 50 gallons of water; or, in smaller quantities, 1½ ounces (10 level tablespoonfuls) with a spreader and wetting agent in 3 gallons of water.

For dusting, use a derris or cube dust containing 0.75 percent of rotenone. To prepare this dust, use 15 ounces of finely ground root (having a 4-percent rotenone content) to 4 pounds and 1 ounce of the diluent (finely ground talc, clay, sulfur, tobacco, or other powder except lime), or 18½ pounds of the root to 81½ pounds of the diluent. If the rotenone content of the derris or cube is greater or less than 4 percent, then the proportions of the inert diluent must be varied accordingly.

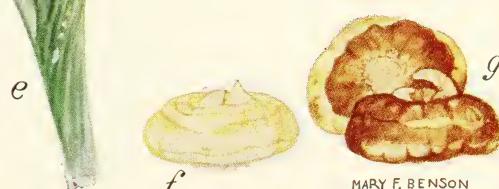
Begin spraying or dusting when the bugs first appear and repeat the treatments as often as necessary.

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GLADIOLUS THRIPS



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a, Adult thrips; b, egg; c, larva; d, pupa (or resting stage); e, foliage and flower spike showing typical feeding injury; f, uninjured gladiolus corm; g, corms injured by feeding of thrips, showing characteristic russeted appearance. (a, b, c, and d about 20 times natural size; e, f, and g about one-half natural size.)

(See other side for life history and control)

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GLADIOLUS THRIPS

(*Taeniothrips simplex* Mor.)

Gladiolus thrips overwinter and may reproduce on the stored gladiolus corms. During the growing season the adults and larvae attack the foliage and flowers of the growing plant. The eggs are inserted into the plant tissue. In the summer a generation of the thrips may be completed in 2 weeks.

The gladiolus thrips can be controlled by applying DDT to the stored corms or the growing plants.

Treatment of the Corms

On dormant corms use a 5-percent DDT dust. Apply 1 ounce of dust per bushel of corms in trays or 1 teaspoonful per 100 corms in paper sacks. Apply the dust with a duster over the top of filled trays soon after the corms are harvested or after cleaning. It is important to destroy the thrips before they penetrate beneath the protecting scales.

Control on the Plants

Watch the growing plants for evidence of thrips feeding. If you observe such feeding, spray or dust with DDT at once and continue at weekly intervals until the flowers appear. If infested plants are not treated until they bloom, the flowers cannot be saved from disfigurement.

Apply the spray as a fine mist, and avoid run-off. For spraying a few plants use 1 ounce, or 6 tablespoonfuls, of 50-percent DDT wet-table powder to 3 gallons of water; for larger quantities use 2 pounds to 100 gallons of water.

If you use a dust, it should contain 5 percent of DDT. Apply it lightly and evenly over the plant.

CAUTION.—Insecticides are poisonous and should be handled with care.

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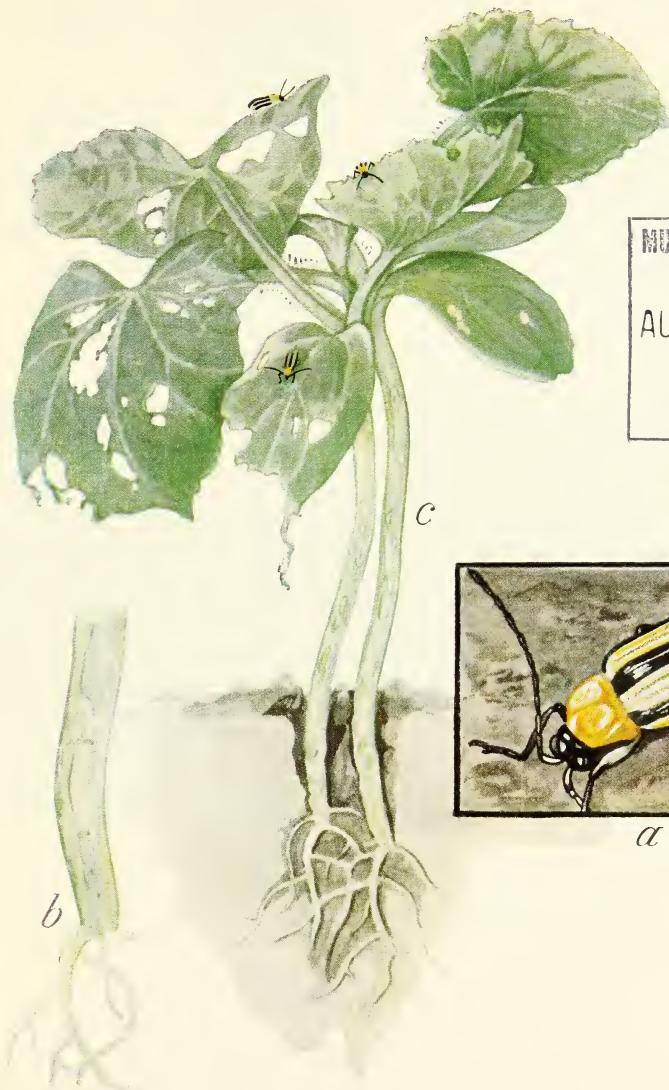
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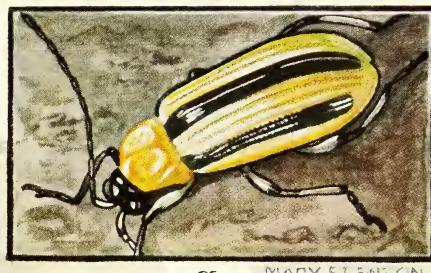
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STRIPED CUCUMBER BEETLE



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α MARY REENSON

a, Adult beetle; b, underground stem of cucumber seedling cut open to show larva (grub, or "worm") feeding within; c, small cucumber plants showing characteristic feeding by adult beetles on leaves and stems. (a about 8 times natural size; b about twice natural size; c about three-fourths natural size.)

(See other side for control measures)

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STRIPED CUCUMBER BEETLE

(*Acalymma vittata* (F.))

The striped cucumber beetle is one of the most familiar insects to gardeners in the Eastern and Central States. It is also one of the most troublesome. The beetles invade cucumber, squash, and melon plantings almost overnight, and often destroy tiny seedlings before they push through the soil. They girdle stems of older plants, and eat portions of the leaves. They also transmit bacterial wilt and mosaic disease from plant to plant. The grubs, or larvae, live on the roots and reduce the vitality of the plants.

The adult beetles spend the winter in uncultivated areas, protected by plant debris. In the spring they become active, feeding on some wild plants about the time apple trees are in bloom. As soon as the first melon, cucumber, squash, or pumpkin seedlings push through the soil, the beetles attack them. Here they feed first on the stems and cotyledons, oftentimes killing the plants. There may be an influx of beetles into the field for several weeks. As the plants grow, the beetles collect under the vines and feed on the lower surfaces of the plants. Females crawl into cracks in the soil and deposit eggs. The young larvae, or grubs, that hatch from these eggs feed on the plant roots for about a month, pupate in the soil, and emerge as adults of the next generation.

Control

Several insecticides are effective, however, provided they reach the beetles in time. Derris or cube and cryolite are recommended for this purpose. They may be applied either as dusts or as sprays to prevent plants from becoming infected by wilt.

The derris or cube dust should contain 0.75 to 1 percent of rotenone, and the cryolite dust 40 to 50 percent of sodium fluoaluminate. They are usually obtainable at these strengths from local dealers.

Sprays can be prepared from undiluted powdered derris or cube, which contains from 3 to 5 percent of rotenone, or from a rotenone-containing extract. Use enough of the powder to give a spray containing 0.02 percent of rotenone. This requires 5½ pounds of a powder containing 3 percent of rotenone, or 4 pounds of one containing 4 percent, in 100 gallons of water. Use the rotenone-containing extract at the strength recommended by the manufacturer. To prepare a cryolite spray use 5 pounds of cryolite containing 90 percent of sodium fluoaluminate or its equivalent in 100 gallons of water.

Apply the dusts at 15 to 30 pounds per acre and the sprays at 75 to 100 gallons per acre, the rate depending on the size of the plants. To be effective the applications must be timely, thorough, and frequent. Keep in mind the following points:

- (1) Protect the young seedlings.
- (2) Apply the dust or spray to the plants as soon as the beetles appear.
- (3) Apply a light, even coating over the entire plant, especially at the point where the stems emerge from the soil.
- (4) Repeat the applications after rains and as often as necessary to keep the plants free from the beetles.

CAUTION.—Insecticides are poisonous and should be handled with care.

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POTATO LEAFHOPPER



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a, Adult leafhopper; *b*, nymphs; *c*, potato leaflets, showing upcurled brown tips and margins, known as hopperburn, caused by the feeding of leafhoppers. (*a* and *b* about 14 times natural size; *c* about $\frac{3}{4}$ natural size.)

(See other side for life history and control)

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POTATO LEAFHOPPER

(*Empoasca fabae* (Harr.))

Injury and Life History

The potato leafhopper is an injurious pest of potato and beans in the Eastern States. It also attacks many other plants. Both the young forms, known as nymphs, and the adults feed upon the under surface of the leaves by sucking the plant juices. The adults fly when disturbed and the tiny nymphs scamper for cover, traveling sidewise. Besides sucking the plant juices, this leafhopper transmits to the plant a substance that causes a disease condition known as hopper-burn. The first symptom of this disease is a triangular brown spot at the tips of the leaflets. Later the entire margins may curl upward and turn brown as though scorched. Badly affected plants die early and the yield of potatoes is reduced.

In Florida and other Gulf States the leafhopper breeds throughout the year. In the North the adults appear in April or May. Since they have never been found there in the winter, they probably migrate from the South. Early in June they move in large numbers to potato fields and deposit eggs in the tissue of the plants. In about a week these eggs hatch into wingless nymphs. The nymphs pass through five stages and become winged adults in 10 to 14 days. They begin laying eggs 5 or 6 days later. The period from egg to adult is about 1 month.

Control

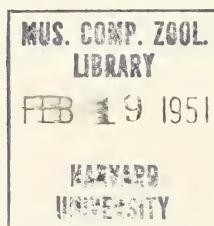
Dust the foliage thoroughly with a 3-percent DDT dust.

If you prefer a spray to a dust, use 2 level tablespoonfuls of 50-percent DDT wettable powder or 2 level teaspoonfuls of 25-percent DDT emulsion concentrate per gallon of water. Apply with a good sprayer that throws a fine mist. To make 100 gallons of spray use either 2 pounds of the 50-percent wettable powder or 2 pints of the 25-percent DDT emulsion concentrate. If spray is to be used for disease control, add either of these DDT preparations to the fungicidal spray rather than to water, and apply at once.

Begin spraying or dusting when the insects first appear and repeat the treatment as often as necessary.

CAUTION.—Insecticides are poisonous and should be handled with care. Store in a dry place where children and animals will not have access to them.

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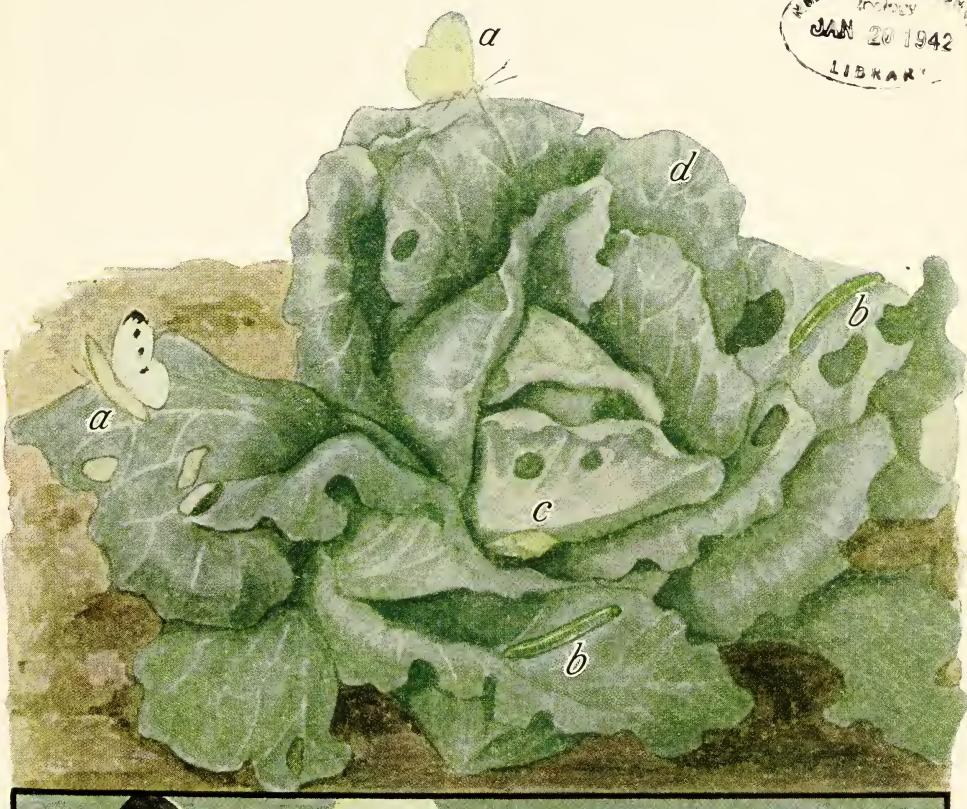
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IMPORTED CABBAGE WORM



MARY F. BENSON

a, a, a, Butterflies (or adults) with wings in natural positions; b, b, larvae (caterpillars, or "worms"); c, c, pupae (chrysalids—the resting stage); d, cabbage plant showing typical feeding injuries. (Upper illustration: a, b, and c about one-half natural size; d slightly less than two-thirds natural size. Lower illustrations: a, b, and c about natural size.)

(See other side for life history and control)

IMPORTED CABBAGE WORM

(*Pieris rapae* (L.))

General Life History

The imported cabbage worm is the larva of a white butterfly, which passes the winter in the chrysalis or pupal stage in the Northern States. In the more southerly States the larvae, or "worms," may be found from March until December, and in some areas throughout the winter. The butterflies emerge from the chrysalids early in the spring. The female butterfly deposits each egg separately, in contrast to the habit of many other insects which deposit their eggs in masses. The eggs are usually laid on the under side of the leaves of cabbage, collards, cauliflower, broccoli, and other food plants. The time required for the various stages of the insect to develop varies with the season. However, the eggs usually hatch within a week, and the larval and pupal stages each develop in from 1 to 2 weeks; so there are several broods each year, ranging from 3 to 6 in different parts of the country. The velvety-green larvae, or caterpillars, are especially fond of the tender, immature heads of cabbage, to which they often cause severe injury.

Control

The imported cabbage worm is readily controlled by the use of one of several insecticides.

The safest and one of the most effective methods is the use of a derris or cube dust mixture containing from 0.75 to 1.0 percent of rotenone. Applications should be made at intervals of about 10 days from the time the caterpillars are first discerned on the plants until such time as the pest is brought under control or the harvesting of the crop is completed. The dust may be obtained already prepared, in which case the amount of rotenone present is shown on the package; or it may be made by mixing the derris or cube root powder with talc, pulverized clay, sulfur, or tobacco dust. For example, to prepare a $\frac{3}{4}$ -percent rotenone dust from a derris powder which contains 4 percent of rotenone, use 1 pound of derris to 5 pounds of the talc or other material; for larger quantities, use 16 pounds of the derris to 84 pounds of other material. For best results the dust applications should be made late in the afternoon or early in the evening when the air is practically calm and the plants are slightly moist with dew. Special care should be given to see that the insects and the "buds," or heads of the plants, are reached by the insecticide. The dosage will vary according to the size of the plants, but should range from about 10 to 25 pounds per acre per application.

Fresh pyrethrum flowers powder (containing approximately 0.9 percent of total pyrethrins) diluted with 2 parts of talc or one of the other materials listed will also give satisfactory control.

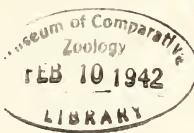
Although dusts have, in general, given better results than sprays in controlling the imported cabbage worm, the materials previously mentioned may be applied as sprays. A spray consisting of from 2 to $2\frac{1}{2}$ pounds of a derris powder (containing 4 percent of rotenone) to 50 gallons of water, to which may be added a nonalkaline spreader or sticker, is recommended. Sprays made from extracts of derris or pyrethrum, or a combination of them, when prepared according to the manufacturer's directions, may also be used.

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SQUASH BORER

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a, Moth (or adult) with wings spread; b, moth with wings partly folded; c, part of squash stem (enlarged) cut open to show borer (or larva) feeding within; d, pupal cell in soil cut open to show pupa (or resting stage) inside; e, part of squash plant showing typical appearance of wilting caused by feeding of squash borer inside the stem. (a, c, and d about 1 1/4 times natural size; b about two-thirds natural size; e about one-third natural size.)

(See other side for life history, injury, and control)

SQUASH BORER

(*Melittia satyriniformis* Hbn.)

Squash vines, in many sections of the country, may wilt suddenly early in the summer. Usually this wilting is due to the squash borer, a caterpillar which bores into the stem near the ground. Its presence may escape notice until piles of yellow, sawdustlike excrement, which falls from holes in the stem, become evident.

Life History

The adult is called a clear-winged moth because the hind wings are transparent, like those of a wasp. The female moth lays eggs on the stems in June or July in the North and in April and May in the South, or earlier in the far South. The minute young larvae, or caterpillars, on hatching from the eggs, bore into the stem, grow rather rapidly, and become full-grown when about 1 inch long, after a period of about 4 weeks. One generation occurs in the North, two in the South, and a partial second generation in intermediate regions. The winter is spent in the soil as mature larvae or as pupae.

Injury

When the borers are numerous they cause severe injury. They bore throughout the interior of the stems near the base and may travel up the stems, even to the petioles of the leaves. Sometimes vines are almost severed. The fruits are sometimes attacked. As the larvae become larger the excrement which is pushed out of holes in the stems becomes visible. While most serious on squashes, especially the Hubbard, the borers also attack pumpkins, cucumbers, gourds, and other cucurbits.

Control

Although control is difficult, the following remedies have been recommended: Apply a dust mixture of derris or cube, diluted with talc, tobacco dust, or some other inert diluent. The mixture should contain not less than 1 percent of rotenone, which is a toxic constituent of derris and cube. Apply the dust to the stems and basal parts of the vines three or more times at 10-day intervals. The mixture may be purchased, or it may be prepared at home by mixing 8 pounds of diluent and 2 pounds of derris or cube containing 5 percent of rotenone (or 6 pounds of diluent and 2 pounds of derris or cube containing 4 percent of rotenone). A spray composed of 1 part of 40-percent nicotine sulfate to 100 parts of water has been reported as effective in reducing infestations. Apply the spray to the stems near the base of the plant, and repeat the application at least weekly during the egg-laying period.

The success of any insecticidal treatment will depend upon early and repeated treatment, because after the young larvae have reached the inside of the stem the insecticides will not affect them.

The practice of covering the stems with soil to induce rooting beyond injured portions has long been followed with success, especially on heavy soils in humid areas.

After the borers have entered the stems and their presence becomes evident, the only known remedy is to slit the stems longitudinally with a thin knife or razor blade and remove the borer. The injured portion should then be covered with soil.

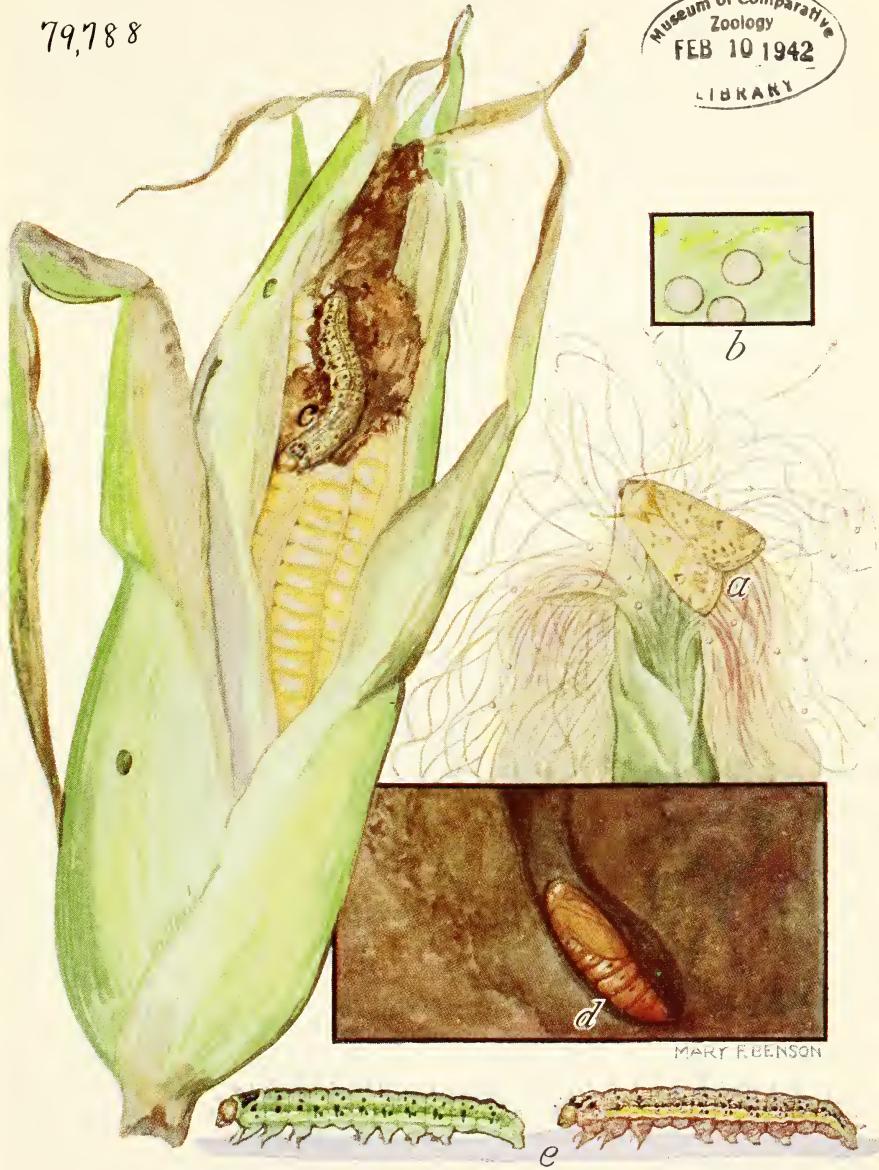
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CORN EARWORM

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a, Moth (or adult), and eggs on silks; b, eggs; c, earworm feeding in ear of corn; d, pupa in a cell; e, color phases of the earworm. (All except b about $1\frac{1}{3}$ times natural size; b $5\frac{1}{2}$ times natural size.)

(See other side for life history and control)

CORN EARWORM

(*Heliothis armigera* (Hbn.))

Life History

Although the corn earworm attacks many cultivated crops, it is dealt with here only as an enemy of corn. The eggs are laid by a moth, or miller, usually on the corn silks. The eggs hatch in from 2 to 8 days, and the tiny larvae, caterpillars, or "worms," feed downward, following the silks into the ear tip. Serious damage to the ear frequently results from their feeding and from the fermentation or molds which follow. When full-grown, the larva leaves the ear, enters the soil, and becomes a pupa, and from this the moth emerges. About 30 days are required in midsummer for complete development from egg to adult. Pupae produced late in the summer or in the fall may pass the winter in the soil and become moths the following spring or early in the summer. Usually two complete generations are developed annually in the North, but in the South there may be as many as five or more generations.

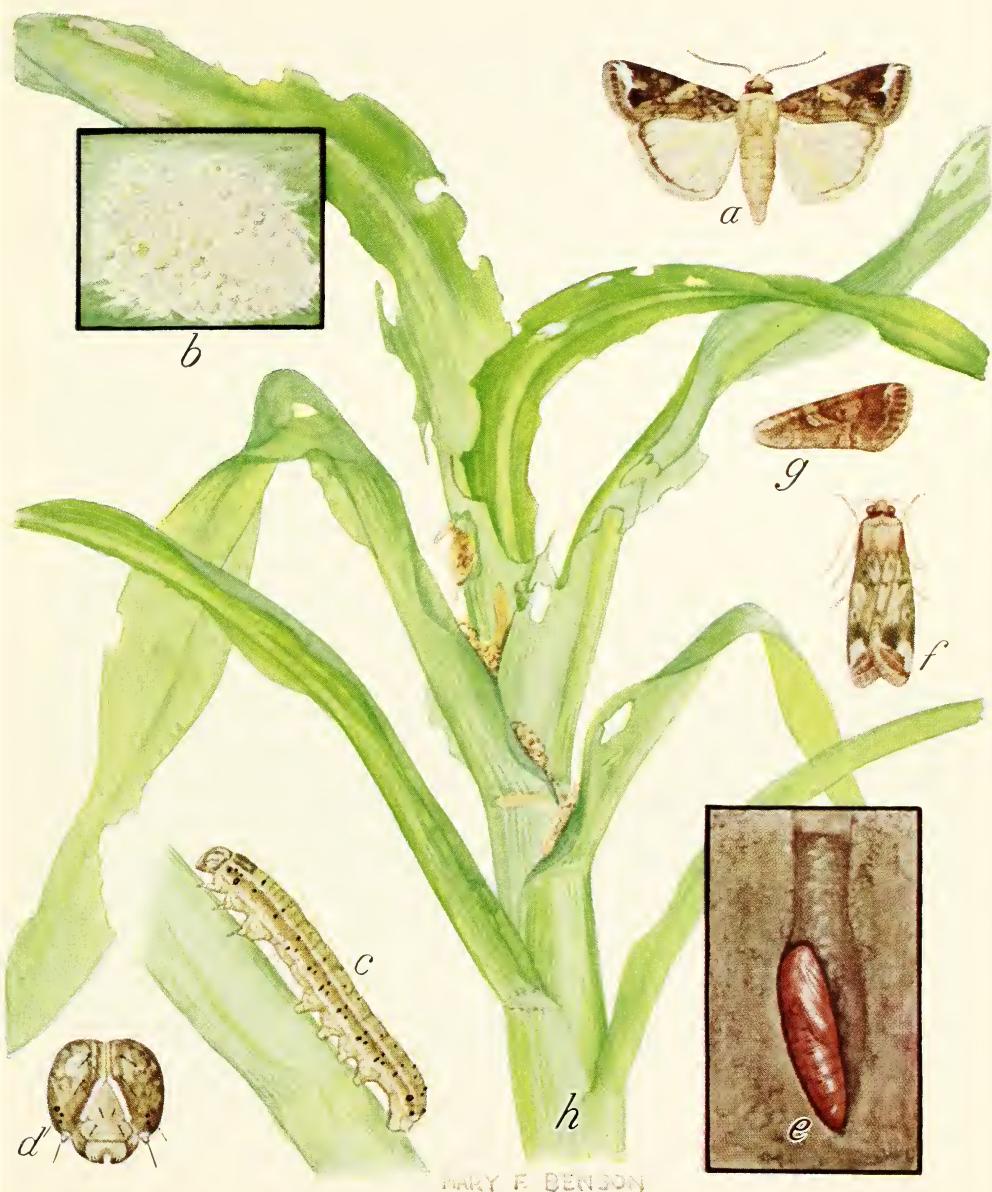
Control

Injury to field corn can be reduced by growing varieties having long, tight husks, and, in the South, by planting early.

To protect early-market or home-garden sweet corn, inject into the tip of each ear about $\frac{1}{4}$ teaspoonful ($\frac{3}{4}$ to 1 cubic centimeter) of refined white mineral oil (viscosity 100 to 200 Saybolt) containing 0.2 percent of pyrethrins. If ready-mixed material is not obtainable, use $1\frac{1}{4}$ fluid ounces of oleoresin of pyrethrum (containing 20 percent of pyrethrins) to 1 gallon of the white oil. The injecting should be done *after the silks have wilted* and before they have begun to turn brown. If it is done before the silks have wilted, poorly filled ears may result. Although the mixture can be applied with a pump-type, long-spouted oil can, it can be best applied by using a special oiler. A description (with illustrations) of the special oiler will be sent, without charge, on application to the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington, D. C.

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FALL ARMYWORM



MARY E. BENSON

a, Male moth (or adult); b, eggs; c, larva; d, face of larva; e, pupa in a cell; f, moth in resting posture; g, wing of female moth; h, feeding injury to corn plant. (a, c, e, f, g, h about $1\frac{1}{3}$ times natural size; b twice natural size; d 8 times natural size.)

(See other side for life history and control)

FALL ARMYWORM

(*Laphygma frugiperda* (A. and S.))

The fall armyworm, known principally as an enemy of growing corn, feeds on many other cultivated crops, such as alfalfa, cotton, peanuts, and grasses, and also on wild plants. The eggs are laid at night on grasses or other plants and hatch in about 5 days. The young larvae (caterpillars, or "worms") feed at first in concealment near the ground, become full grown in about 20 days, and then enter the soil for a few inches and change into pupae. The inactive pupal stage lasts about 10 days. After the moths emerge from the pupal cases they often fly many miles before the females lay eggs. The fall armyworm may have as many as six generations a year in the Gulf States, but does not survive the winter farther north. In addition to eating the blades of corn and boring into the stalks, the larvae may bore into the ears, particularly the shanks of the ears, and feed extensively therein.

Control

The fall armyworm can be controlled with the following sprays: (1) 2 pounds per acre of a wettable powder containing 50 percent of either DDT or TDE, mixed with 40 gallons of water. (2) A toxaphene emulsifiable concentrate, applied by aircraft at the rate of 1½ to 2 pounds of toxaphene in 2 gallons of spray per acre.

The application of a dust containing 5 percent of DDT, toxaphene, or TDE, at the rate of 40 pounds per acre, or a 20-percent toxaphene dust at 10 to 15 pounds per acre, has also been reported to give good control.

To control so-called "budworm" damage in sweet corn, caused by the feeding of this worm deep in the whorls of the corn plant, spray with an emulsion made with 3 quarts of a 25-percent DDT emulsifiable concentrate, 5 quarts of a white mineral oil of 50 to 95 seconds Saybolt viscosity, and enough water to make 25 gallons of spray. Apply the spray at the rate of 25 gallons per acre.

When the worms are crawling over the ground in large numbers they may be destroyed by broadcasting a poisoned bait thinly over the infested fields, and moderate infestations in corn may sometimes be controlled by light sprinklings of the bait in the leaf whorls. To prepare this bait mix 50 pounds of wheat bran with 2 pounds of paris green, and then add 6 gallons of water to make a damp mash. This quantity is enough for 2 to 3 acres.

Warning: All these insecticides are poisons. They must be kept out of reach of children or animals and must be handled with care, according to directions on the containers. Because the residue of DDT, TDE, or toxaphene may be dangerous to humans and livestock, hay or forage that has been treated with these insecticides should not be fed to dairy animals or to meat animals being finished for slaughter. Paris green is a strong poison. Thoroughly wash out containers that have been used for mixing bait. Dispose of surplus bait by broadcasting it thinly on the ground in a field.

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TOMATO FRUITWORM



a, Female moth (or adult) with wings spread; *b*, male moth with wings in natural position; *c*, eggs; *d*, larva; *e*, pupa (or transformation stage) in its cell in the soil; *f*, larva feeding on tomato fruit, showing typical injury. (*a*, *b*, and *f* about two-thirds natural size; *c* about seven times natural size; *e* about one and one-third times natural size.)

(See other side for life history and control)

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TOMATO FRUITWORM

(*Heliothis armigera* (Hbn.))

Life History

The tomato fruitworm, or corn earworm, occurs over the entire United States and feeds on several crops, including tomatoes, cotton, and corn. In the Southern States and in California it is a serious pest of tomatoes every year. In the extreme South moths may emerge as early as January from their pupal cells, although most of them appear later in the spring. Shortly after the female moth emerges she begins to lay her eggs, which are somewhat smaller than the head of a common pin. She lays them singly on the leaves of the plant. As the larvae hatch they crawl over the leaves, feeding sparingly. They eventually find their way to the fruits, into which they cut holes or burrow, usually at the stem end. A worm may feed until full grown upon a single tomato, or it may move from one tomato to another, injuring several before it completes its growth. The full-grown worm leaves the fruit and enters the soil, where it transforms into the pupal or resting stage. There may be two or more broods a season.

Control

A satisfactory remedy for this pest is a 10-percent DDT dust. In localities where the tomato russet mite is a pest the dust should also contain at least 25 percent of sulfur. Where the tomato russet mite is not a pest, corn meal containing 10 percent of cryolite has also given satisfactory control.

Best results will be obtained by making three applications—the first when the plants are about 1 to 2 feet across and are beginning to set fruit, and the second and third applications after intervals of 14 days. The DDT dust should be applied at 30 pounds per acre, and the corn-meal mixture at 60 pounds per acre per application. The entire foliage should be covered, especially the growing tips and outer leaves of the plants. The dust should be applied with hand or power dusters. The corn-meal mixture may be scattered by hand.

CAUTION.—DDT and cryolite are poisons. Their use on the tomato crop may leave an undesirable residue on the fruit, which should be removed by washing or wiping before the fruit is marketed or eaten.

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EUROPEAN CORN BORER





EUROPEAN CORN BORER

(*Pyrausta nubilalis* (Hbn.))

Life History

Although the European corn borer attacks many cultivated crops and weeds, it is discussed here mainly as an enemy of corn, its favorite host plant. The eggs are laid overlapping one another like fish scales, in masses of 15 to 20 or more on the under sides of the corn leaves, and hatch in 4 to 9 days. The tiny borers immediately crawl to protected places on the plants, where they feed on the tissues of the immature leaves and tassels, and eventually bore inside the stalks and into the ears. They become full grown in about a month and, after providing an exit for the adult moth, change to pupae inside the burrows, either at once or after an inactive period. In 10 to 14 days the adult moths emerge from the pupal cells and lay about 400 eggs each on corn or other plants that they may find in an attractive stage of growth. The moths live from 10 to 24 days. They are active fliers during the evening or night and may migrate several miles. These insects pass the winter in the borer stage inside infested stems of corn or other plants, and here they change to moths late in the spring or early in the summer. There are one or more generations a year, depending on the length of the growing season in different latitudes.

Control

- A. Destroy overwintering borers by disposing of infested cornstalks—
 1. By feeding to livestock direct or as silage or in finely cut or shredded form.
 2. By plowing under clean in the fall or in early spring before the moths emerge, using attachments such as trash shields, wires, or chains to insure burial of all stalks.
 3. By burning infested plants completely, where other methods of disposal cannot be used.
- B. Plant as late as practicable, but only within the normal planting period adapted to the locality. Moths of the first brood lay their eggs on the earliest planted corn.
- C. Plant resistant or tolerant kinds of hybrid corn. No immune strains are available, but hybrids differ in their resistance and tolerance. Select types that will mature when planted moderately late. Consult your county agent or your State experiment station on the best hybrids to plant in your locality.
- D. Modify cropping practices.
 1. Avoid sowing fall wheat or other small grain in standing corn or corn stubble. Plow the cornstalks under clean or cut them at ground level and remove them before seeding small grain.
 2. Dispose of all early sweet cornstalks in fields and gardens immediately after harvesting the ears, by feeding, ensiling, or plowing them under. Dispose of cobs and other remnants from the cannery in the same manner.
- E. Use insecticides where profitable. Consult your county agent or State experiment station for current recommendations.

Apply as many of the measures suggested above as may be practicable under local conditions. Community application of these methods is necessary for most effective control. Control of this insect is essential to the maximum production of corn so urgently needed for food and feed purposes.

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April 1948

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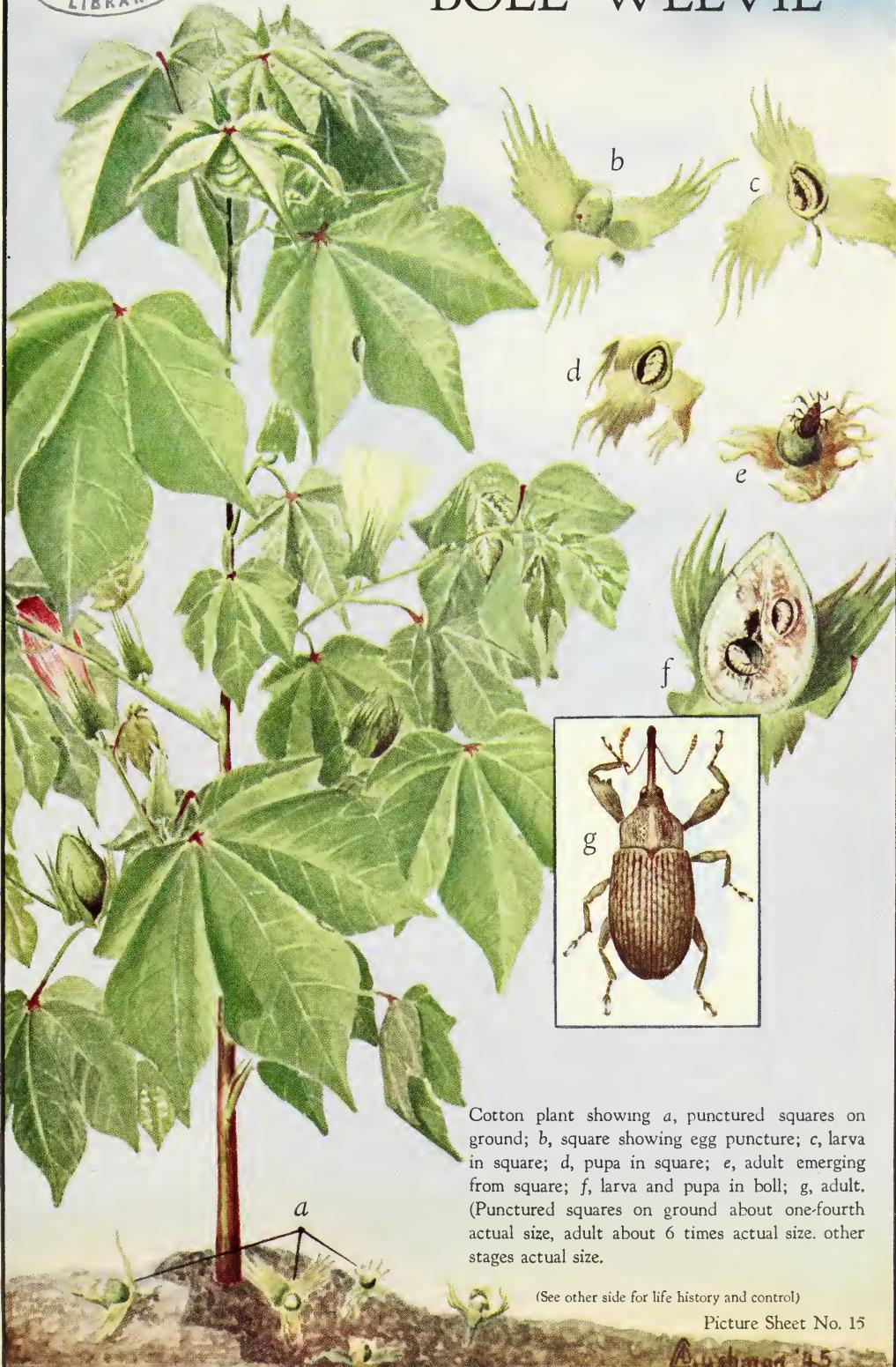
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BOLL WEEVIL

ED



Cotton plant showing *a*, punctured squares on ground; *b*, square showing egg puncture; *c*, larva in square; *d*, pupa in square; *e*, adult emerging from square; *f*, larva and pupa in boll; *g*, adult. (Punctured squares on ground about one-fourth actual size, adult about 6 times actual size. other stages actual size.)

(See other side for life history and control)

Picture Sheet No. 15

BOLL WEEVIL

(*Anthonomus grandis* Boh.)

Life History

Boll weevils pass the winter as adults in weeds, grass, woods trash, or other protected places near cottonfields. They leave winter quarters and return to cottonfields in the spring when the weather is warm enough for cotton to grow, and they remain there until frost. Boll weevils prefer to feed on and to lay their eggs in squares, but they also attack bolls. Eggs are laid singly in deep punctures made within the squares or bolls, and after 3 to 5 days they hatch into white larvae, or grubs. The grubs feed for 7 to 14 days and then change into pupae within the squares or bolls. The adults emerge from the pupae in 3 to 5 days and cut their way out. After feeding on blooms, squares, or bolls for 3 to 4 days, the females are ready to lay eggs. The complete life cycle from egg to adult weevil requires about 3 weeks when temperatures are high, and there may be seven or eight generations a season.

The leaflike bracts at the base of the punctured squares open up, or flare, and the square turns yellow and dies. Most of the punctured squares and small bolls are shed, but some remain hanging to the plants. Large punctured bolls are not shed, but the lock in which a grub feeds fails to develop properly, and the lint is cut, stained brown, and decayed. When several weevil grubs develop within a boll, as often occurs, the entire boll is ruined.

Control

Cultural Control

Farming practices that help set bolls quickly will aid in weevil control. These practices are as follows:

1. Plant cotton on good land that has been well prepared.
2. Use fertilizer recommended for your locality.
3. Select an early maturing variety suited for growing in your section.
4. Plant early, space closely, and cultivate frequently.
5. Pick early and cleanly. After the cotton has been picked, stop further fruiting by plowing out, cutting, or grazing the cotton stalks as early as possible in the fall, to reduce the number of weevils in next year's crop.

Control with Dusts

Dusting with calcium arsenate during the time cotton is fruiting is the most practicable method of direct control. To determine when dusting is needed, examine squares once a week or oftener for weevil punctures. Walk diagonally across the field and pick 100 squares that are half-grown or larger. Pull only 1 square from a plant, taking about the same number from topmost, middle, and lowest branches. When 100 squares have been picked, count those having weevil punctures to determine the percentage of infestation. On light soils where cotton does not grow rank and matures early, dusting should begin when 10 to 15 percent of the squares are punctured. On fertile soils where cotton continues to grow and fruit until late in the season, do not begin dusting until 20 to 25 percent of the squares are punctured.

Dust with 5 to 7 pounds of calcium arsenate per acre every 4 or 5 days until the weevils are brought under control, or until a crop of bolls is set. It is advisable to mix 1 or 2 percent of nicotine with the calcium arsenate to prevent aphid damage. Repeat if the dust is washed off by rain within 24 hours. From three to five applications will usually control weevils and result in the setting of a crop. From one to three dustings are sometimes needed to protect bolls.

Dusting may be done early in the morning, late in the afternoon, or at night, when the air is quiet. It is more important to dust when the air is calm than when the plants are wet with dew.

Low winter temperatures and hot, dry summers help control the boll weevil. Watch for a rapid increase of weevils and severe damage during rainy periods.

Plant lice, or aphids, can be held in check by adding nicotine to the calcium arsenate. Nicotine should not be applied during midday, when the dust has a tendency to rise. For effective aphid control it is necessary that the dust containing nicotine stay down among the plants, not rise and float away.

Caution: Calcium arsenate is a poison and should be handled with care. Store it in a dry place where children and animals will not have access to it.

BOLLWORM

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a, Eggs; b, egg (15 times natural size); c, young larva on square; d, damaged square; e, full-grown larvae showing color differences; f, pupa in soil; g, adult. Eggs about 15 times natural size; other stages, about natural size.

(See other side for life history and control)

Picture Sheet No. 16

BOLLWORM

(*Heliothis armigera* (Hbn.))

Life History

The bollworm damages cotton wherever it is grown in the United States, but the losses are usually greatest in Texas, Oklahoma, and Louisiana. It also feeds on many plants besides cotton, especially corn and tomato, and is known as the corn earworm and the tomato fruit-worm. Cotton is not the preferred food plant. Bollworm infestations usually develop rather late in the season, about the time corn silks are drying out and after dusting the boll weevil control has been completed. Each bollworm destroys a large number of squares and bolls, and when bollworms are numerous a crop of cotton can be ruined in a very short time. Damage often occurs so late in the season that the plants do not have time to mature another crop of bolls.

The bollworm moths prefer rapidly growing, succulent cotton in which to lay their eggs. The eggs are laid singly on the tender growth and newly formed squares. They are smaller than the head of an ordinary pin, and pearly white when first laid, but change to a dark color before hatching. The small larvae, or "worms," feed for a few days on the tender buds or leaves and on the outside of squares before burrowing into squares or bolls, usually near the base. Large worms feed almost entirely inside the bolls, so that it is very difficult, if not impossible, to control them. Full-grown larvae enter the soil and change to the pupal, or resting, stage. There are several broods a year. The last brood passes the winter in the underground pupal cells.

Control

When it is about time for bollworms to appear, examine the tops of the plants frequently for eggs and small worms. When 20 to 25 eggs that are beginning to hatch, or this number of eggs and very small worms, are found per 100 plants, it is time to begin dusting. *Successful bollworm control requires heavy applications of dust while the eggs are hatching and before the worms enter the bolls.*

At 5-day intervals apply 10 to 15 pounds per acre of a 10 percent DDT dust, a dust containing 5 percent of DDT plus sufficient benzene hexachloride to give 3 percent of the gamma isomer, or a 20 percent toxaphene dust. Calcium arsenate, lead arsenate, and cryolite are less effective. Whenever the red spider must also be controlled, any mixture containing organic insecticides should include at least 40 percent of sulfur. Use more pounds per acre when the infestation is heavy and the plants are large. Two or three applications will usually control a brood of bollworms, but there may be more than one brood or a steady movement of egg-laying moths to cotton from other crops, with no distinct broods. In such cases several additional applications may be needed to keep the plants covered with insecticides to kill the newly hatched worms. Ladybird beetles and other natural enemies or extremely hot, dry, windy weather often destroys enough eggs and young bollworms to control a threatening infestation without the use of insecticides. Nicotine or benzene hexachloride may be added to the insecticides to prevent aphids from becoming injurious.

Caution.—Insecticides are poisonous and should be handled with care. Store in a dry place where children and animals will not have access to them.

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COTTON APHID



a, Curled infested leaves; b, aphids on under side of leaf; c, aphids on stem; d, honeydew on leaf; e, winged female; f, wingless female; g, young. a, b, c and d actual size; females and young about 14 times actual size.

(See other side for life history and control)

Picture Sheet No. 17

COTTON APHID

(*Aphis gossypii* Glov.)

Life History

The cotton aphid, also known as the cotton louse and the melon aphid, is found throughout the United States. It is a general feeder and, in addition to damaging cotton, is a pest of okra, melons, squash, cucumbers, and other cucurbits. It is a small, soft-bodied, sucking insect; its color ranging from light yellow to dark green or almost black. In the Northern States both sexes occur and eggs are laid, but in the South only females that give birth to living young are known. Some of the adults are winged for flying to other plants, while others are wingless. The aphids spend the winter on various weeds, from which they spread to cotton early in the spring. Reproduction is continuous throughout the year in the South and becomes very rapid during warm weather. There are no distinct broods, and aphids of all sizes are present on the under side of the leaves and on the stems of plants. The natural controls, such as ladybird beetles and other predators, parasites, diseases, and unfavorable weather, are important factors in controlling aphids. Aphids are present in almost every field of growing cotton, and during cool, wet springs they often cause curling of the leaves, stunting of growth, or even the death of small cotton seedlings. The greatest damage, however, is done later in the season by causing the leaves to curl and fall from the plant before the bolls are mature. The premature shedding of leaves causes serious losses in yield and grade of cotton. Aphids secrete a sticky substance known as honeydew, which drops on the leaves and bolls below and gives the plants a glossy appearance. A fungus often develops in the honeydew and causes the plants to appear black, or sooty. Honeydew falling on the open bolls also makes the lint gummy and difficult to gin.

Control

Aphids are more likely to damage cotton that has been dusted with arsenicals or DDT than they are undusted cotton. It is more profitable to prevent the aphids from becoming numerous by adding nicotine to the calcium arsenate or other dusts used to control cotton insects than it is to control an aphid outbreak. Adding 1 percent of nicotine to the calcium arsenate used in each application, or adding 2 percent of nicotine to the calcium arsenate used for every other application, will prevent aphids from building up injurious populations. After heavy infestations have developed, 3 percent of nicotine in hydrated-lime dust at 6 to 8 pounds per acre may be needed for control. A 1-percent nicotine dust can be prepared by adding 1 quart of nicotine sulfate solution (40-percent nicotine), and the 2- and 3-percent dusts by adding 2 and 3 quarts of nicotine sulfate, to approximately 100 pounds of calcium arsenate. Other forms of nicotine, such as free or fixed nicotine, are as satisfactory as the sulfate when used at the same strengths. Nicotine can be added to DDT dust in the same way as to calcium arsenate. The nicotine must be thoroughly mixed with the other insecticides, preferably with special mixing machinery in a commercial plant. The best aphid control is obtained by applying nicotine *when the air is very quiet*. It is necessary that the dust containing nicotine stay down among the plants, not rise and float away as often happens when dust applications are made during midday. Complete coverage of the plants is necessary.

E. D.

U. S. Bureau of Entomology

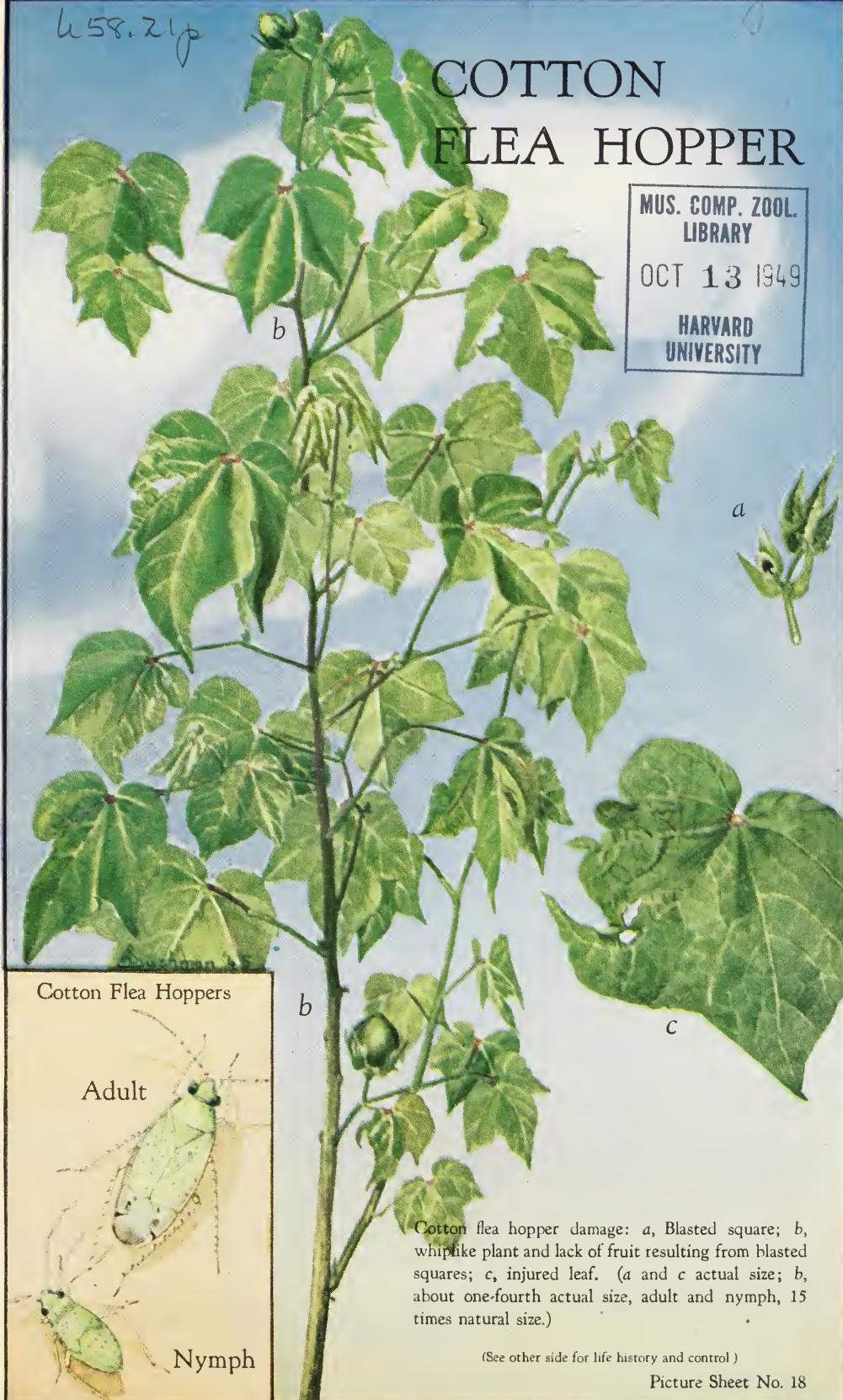
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COTTON FLEA HOPPER

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Cotton flea hopper damage: *a*, Blasted square; *b*, whiplike plant and lack of fruit resulting from blasted squares; *c*, injured leaf. (*a* and *c* actual size; *b*, about one-fourth actual size, adult and nymph, 15 times natural size.)

(See other side for life history and control)

Picture Sheet No. 18

COTTON FLEAHOPPER

(*Psallus seriatus* (Reut.))

Life History and Injury

The cotton fleahopper infests cotton throughout the Cotton Belt. It causes the greatest damage in Texas, Oklahoma, and Louisiana, but in some years losses are also serious in other States. This pest often becomes sufficiently numerous on cotton to cause almost complete loss of the crop.

The cotton fleahopper lays eggs in the stems of croton (goatweed), other weeds, and to some extent in cotton, where they remain during the winter. The eggs hatch early in the spring, and the population builds up rapidly on certain tender weeds, such as horsemint, croton, and evening primrose. There is some movement to cotton, and this migration increases as the weed hosts become tough. Rainfall is favorable to the breeding on cotton, which continues as long as the plants are succulent. When the squaring season is over, the leafhoppers return to weeds to feed and to lay their eggs. A generation of fleahoppers requires from 2 to 3 weeks.

Both the winged adults and the wingless nymphs, or young fleahoppers, are very active and are difficult to see until one becomes accustomed to looking for them. Both stages feed on the juices of the tender parts of the cotton plants, especially the terminal buds and small squares. The leaves become deformed and somewhat ragged in appearance, but the greatest damage is caused to the small squares. Many of the squares are killed when they are no larger than a pinhead, and they turn brown or black and fall from the plants. Because they are so small they are frequently overlooked, and the failure of the plants to bloom is sometimes attributed to weather or other unfavorable conditions. The infested plants grow taller and more whiplike, with fewer large branches than normal plants, and usually produce only a few bolls near the tops.

Control

If cotton is not squaring properly, or if young cotton fails to set small squares, the terminal buds should be examined for fleahoppers. Dusting should be started when 15 to 25 fleahoppers are found per 100 terminal buds.

The following dusts have proved effective: Toxaphene 10 percent, DDT 5 percent plus sulfur 75 percent, benzene hexachloride containing 1 percent of the gamma isomer, and chlordane 2 percent. Less effective control may be obtained with sulfur alone or with a 2-to-1 mixture of sulfur and calcium arsenate. When spider mites are likely to be a serious problem, 40 percent of sulfur should be added to organic insecticides. Two or three applications at intervals of 5 to 7 days will ordinarily give control, but where infestations are heavy, or large numbers of fleahoppers are continually moving into cotton, from four to six dustings may be needed. Experimental work to date indicates that two applications of the organic dust mixtures will control fleahoppers throughout the season.

Caution.—Insecticides are poisonous and should be handled with care. Store in a dry place where children and animals will not have access to them.

Revised April 1949

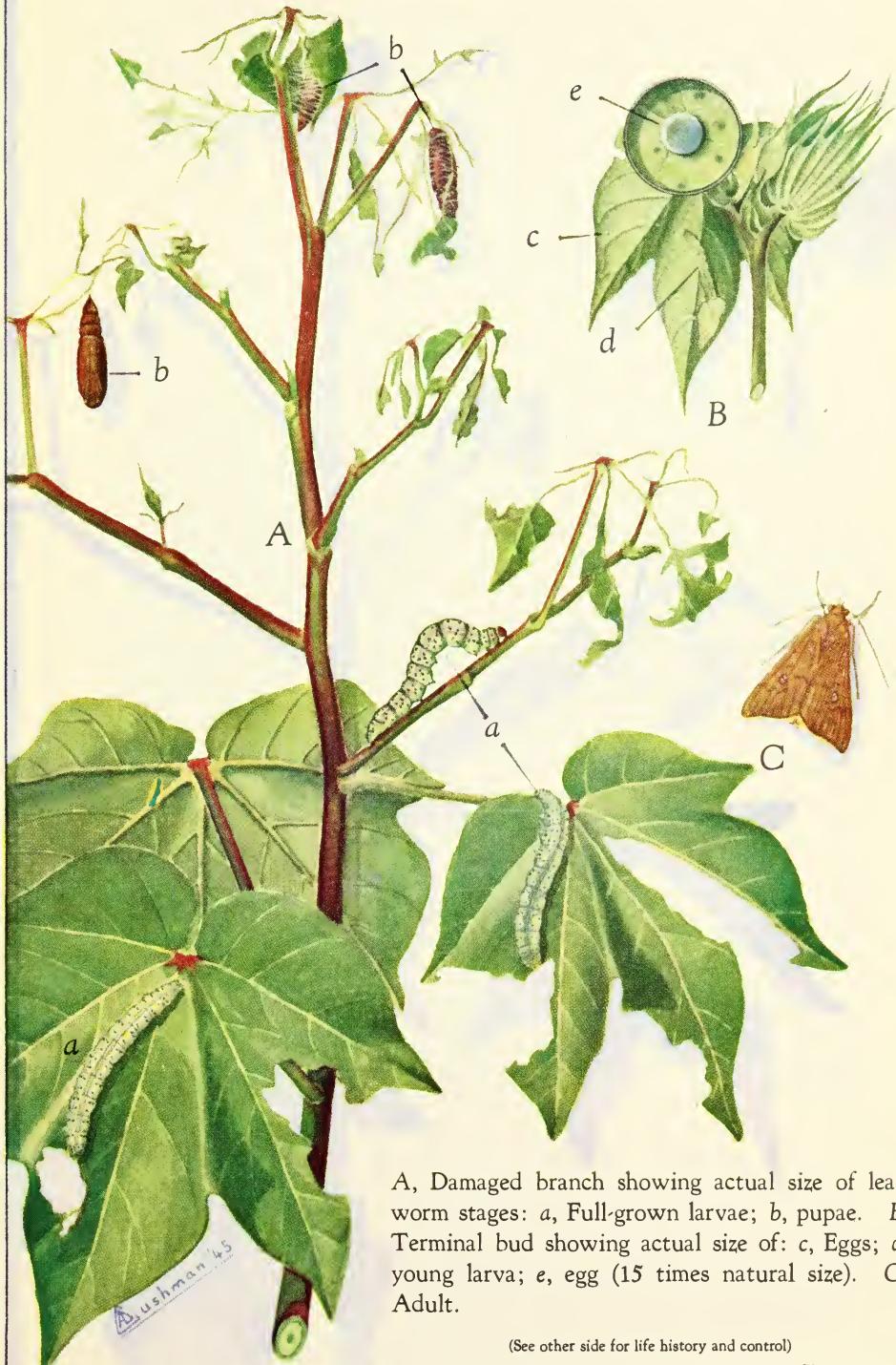
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COTTON LEAFWORM



A, Damaged branch showing actual size of leaf-worm stages: a, Full-grown larvae; b, pupae. B, Terminal bud showing actual size of: c, Eggs; d, young larva; e, egg (15 times natural size). C, Adult.

(See other side for life history and control)

Picture Sheet No. 19

COTTON LEAFWORM

(*Alabama argillacea* (Hbn.))

Injury and Life History

The cotton leafworm is a tropical insect not known to survive the winters in the United States. New infestations are started each spring by moths that fly in from the South and lay their eggs on cotton. The first leafworms generally appear in April, May, or June, usually in southern Texas but sometimes in Florida. As the leafworms increase in numbers, the moths fly to other areas, and in some years all the cotton States except California are invaded. The moths often reach the Northern States and Canada and feed on ripe fruit, such as peaches or grapes. The larvae, or "worms," feed only on cotton. The small leafworms feed on the under side of the leaves and do not cut through the upper surface. The larger worms eat the entire leaf and when abundant completely strip, or "rag," the leaves and then gnaw on the squares, bolls, and bark until the field looks as if it had been swept by fire. The brown pupae are formed within a folded leaf or are attached by a silken cord to the stems and ribs of the leaves.

The spread of the leafworm varies greatly from year to year. Although damage is usually greater west of the Mississippi River, control is often needed in the Eastern States. Early ragging of the plants prevents bolls from maturing and causes reductions in the yield and quality of the cotton. The stripping of the leaves by leafworms after most of the bolls are mature may be beneficial in preventing boll weevils from increasing and in keeping the bolls from rotting on rank cotton by admitting more sunlight to the plants and permitting better circulation of air.

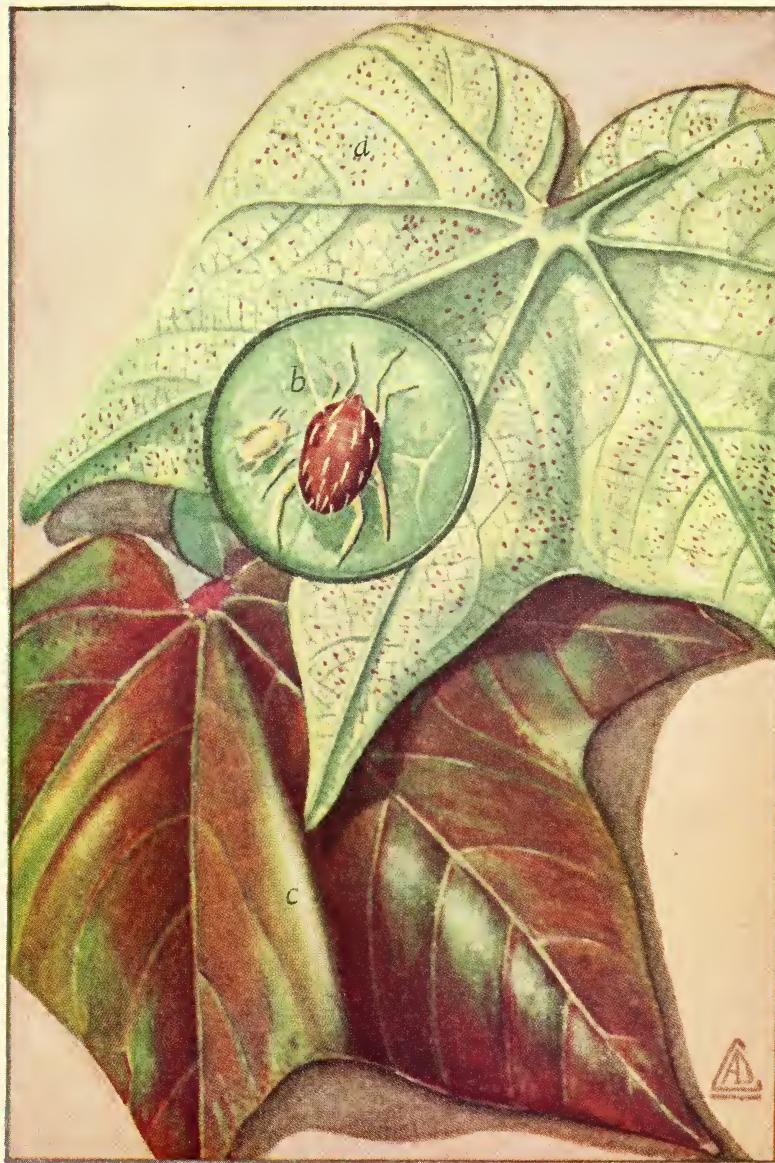
Control

Small cotton leafworms can be controlled very easily by dusting or spraying with any of the arsenical insecticides. Large worms are more difficult to control and may cause considerable stripping before they are killed. Dusting with 5 to 7 pounds per acre of calcium arsenate or lead arsenate will control leafworms. Lead arsenate applied as a spray at the rate of 4 to 6 pounds in 50 gallons of water for each 3 acres is also satisfactory. If a quick kill of large worms is needed to prevent stripping, add 7 or 8 pounds of paris green to each 100 pounds of calcium arsenate, or use 8 to 10 pounds of paris green with 100 pounds of lime.

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RED SPIDER



a, Red spiders (actual size) on under side of leaf; b, adult and young (40 times actual size); c, leaf rusted from red spider feeding.

(See other side for life history and control)

Picture Sheet No. 20

Bureau of Entomology and Plant Quarantine, Agricultural Research Administration
United States Department of Agriculture

RED SPIDER

(*Tetranychus bimaculatus* Harvey)

Life History and Injury

The mites known as red spiders are so small that they can hardly be seen without the aid of a magnifying glass. They may be greenish or yellowish in color, but the females are usually reddish and the smaller males reddish yellow. Red spiders are found throughout the Cotton Belt and feed from June to September on almost 200 kinds of plants, including many garden and field crops, ornamentals, and weeds. In the South they pass the winter on leaves that remain green, such as wild blackberry, Jerusalem-oak, wild vetch, and violet. The red spiders move to cotton early in the summer, and when cotton is no longer suitable for food they return to weeds or other plants. They crawl on the ground and are carried by wind or by rainwater. Red spiders multiply rapidly and may have as many as 17 generations a year. Hot, dry conditions are most favorable for rapid multiplication, and a heavy rain often checks an outbreak. Red spiders live on the under side of the leaves, where they lay their eggs and spin delicate webs. They suck the sap from the leaves, the under surfaces of which become thickly dotted with whitish feeding punctures. Red spider injury is often called "rust." It is first indicated by blood-red spots on the upper surface of the leaves. The entire leaf then reddens or turns rusty brown, curls, and drops from the plant. The loss of leaves causes shedding of small bolls and may prevent the lint from developing properly in large bolls. Damage is more serious in the Southeast, but occurs in all cotton-growing States.

Control

Preventing the spread of red spiders to cotton by destroying weeds around the fields and by controlling the pest on dooryard plants is of first importance. Pulling out and destroying the first few cotton plants that become infested often stamps out an infestation. Dusting cotton with finely ground sulfur at the rate of 10 to 25 pounds per acre is the most practical direct-control measure. Satisfactory control is also obtained by spraying with the following insecticides: (1) Potassium sulfide (1 ounce in 2 gallons of water); (2) lime-sulfur (home-made or commercial); (3) kerosene emulsion (2 gallons of kerosene and $\frac{1}{2}$ pound of soap to 12 gallons of water);¹ and (4) flour paste (cook 1 pound of flour in 1 gallon of water until smooth and add 12 gallons of water). A second application a week later is necessary to kill the red spiders that have hatched since the first application. Care should be taken to cover the under side of the leaves thoroughly with the dust or spray.

¹ To make a kerosene emulsion take 1 gallon of soft water, one-half pound of laundry soap, and 2 gallons of kerosene. Dissolve the soap in the water by boiling, add the kerosene immediately on removing the soapy water from the fire, and pump the mixture vigorously for about 10 minutes through a spray pump into another container. For spraying cotton, this stock mixture should be diluted with 12 gallons of water.

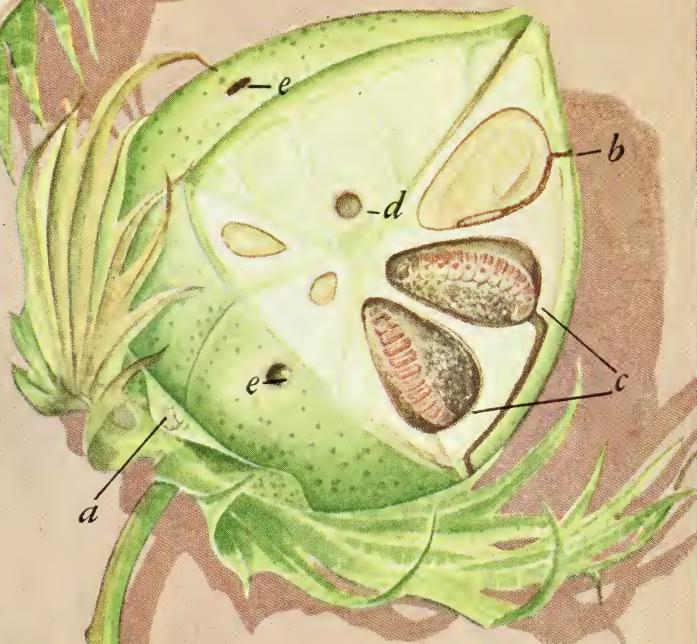
PINK BOLLWORM

Picture Sheet No. 21

A



B



E

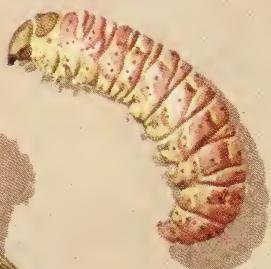


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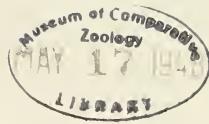
(See other side for
life history and control)

F



C

A, Cotton bloom rosetted by feeding of the pink bollworm. *B*, Green cotton with the boll sectioned: *a*, Eggs laid inside the calyx of cotton boll; *b*, entrance hole made by newly hatched larva (invisible to naked eye); *c*, larvae in cotton seed; *d*, hole in partition made by a larva traveling from one lock to another; *e*, exit holes of larvae. *C*, Mature larva. *D*, Pupa. *E*, Adult. *F*, Damaged open boll. *A*, *B*, *F*, twice actual size; *D*, and *E*, $3\frac{1}{2}$ times actual size; *C*, 5 times actual size.



THE PINK BOLLWORM

(*Pectinophora gossypiella* Saunders)

Injury and Life History

The pink bollworm is the most serious pest of cotton in many parts of the world, including India, China, Egypt, Brazil, and Argentina. It occurs in the principal cotton-growing areas of Mexico, except near the west coast and in Lower California. The pink bollworm was first discovered in the United States near Hearne, Tex., in September 1917. It is now present in only 5 of the 19 cotton-growing States—Arizona, New Mexico, Texas, Oklahoma, and Florida. Infestations in Louisiana and Georgia have been eradicated. Were it not for the persistent and effective fight conducted during the past 30 years by the United States Department of Agriculture and the States in which this insect has made its appearance it would now be in all the cotton-growing areas.

The small pinkish caterpillars eat out the seeds of the cotton plant and thus reduce the yield, weight, vitality, and oil content of the seeds. They also reduce the quantity and quality of the lint. Severe infestations cause squares and small bolls to shed. The female lays from 100 to 200 eggs, which are scarcely visible to the naked eye. The young caterpillar bores into a square or boll, where it feeds for 10 to 14 days. When full grown, it cuts a round hole through the boll and either changes to a pupa within the boll or drops to the ground to pupate. Development from egg to adult requires 25 to 30 days in midsummer. There may be as many as 4 to 6 generations a year where long growing seasons occur. Larvae that develop late in the season may pass the winter in seed, old bolls, trash in the fields or at the gins, and in cracks in the soil.

Control

A strict quarantine is maintained on those areas in which the pink bollworm occurs, to regulate the movement of products likely to carry the pest to other cotton-growing districts. The most successful method of combating an outbreak of the pink bollworm in an area not highly susceptible to constant re-infestation from old infested areas is elimination of cotton production for 1 to 3 years. An important method of control is a combination of cultural practices designed to shorten the breeding season for the insect and to reduce carry-over of larvae from one season to the next. It consists in planting quick-maturing types of cotton within a short period as early in the year as possible, early destruction of cotton stalks to create a host-free condition, destruction of stub or volunteer plants before they fruit, and deep plowing to cover overwintering larvae and thus prevent moths from emerging. Cutting and piling of stalks and shattered debris, followed by burning of the entire mass, will also destroy many overwintering larvae. Heavy winter irrigations are helpful where possible. Treating of cottonseed to destroy any pink bollworms present, together with sanitary measures such as burning of gin trash at the gins, is essential. DDT shows promise as a supplement to other control measures.

Any insect resembling the pink bollworm which is found in areas thought to be free of this insect should be placed in a bottle of diluted alcohol and sent to the Bureau of Entomology and Plant Quarantine, Washington 25, D. C., with full information as to date and place of collection and by whom.

APRIL 1948

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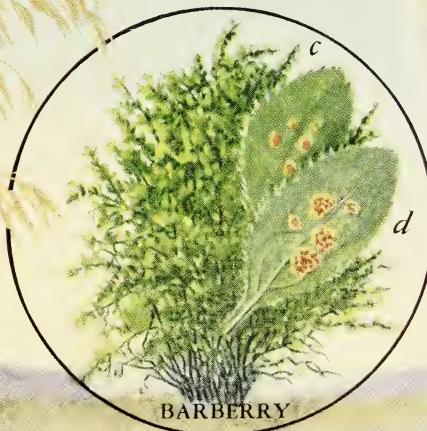
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STEM RUST

(See other side for
life history and control)

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WHEAT
OATS
BARLEY
RYE



a. Germination of overwintered black teliospores; b, sporidia or secondary spores (arrows) that infect susceptible barberry bushes; c, pycniospore or sexual stage on upper surface of barberry leaf; d, aeciospore or cluster-cup stage on lower surface of barberry leaf; e, urediospore or red stage on grain stem; f, teliospore or black stage on grain straw. (All greatly enlarged.)

Wheat From Rust-Infected Plants



Wheat From Rust-Free Plants

STEM RUST AND THE BARBERRY

(*Puccinia graminis* Pers.)

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LIFE HISTORY

The stem rust disease of wheat, oats, barley, and rye is one of the most destructive of all the fungus diseases that attack small grains. Every year it reduces yield and quality of these crops in some areas. In epidemic years it has caused losses in the United States of more than 180,000,000 bushels of grain.

In some areas, the fungus lives part of its life on grains and grasses and part on certain barberries. During the life cycle it produces several distinct kinds of tiny, seedlike spores. Spores scattered by the wind transmit the fungus from one host plant to another. There are several varieties and numerous races of the stem rust fungus, which differ in their ability to attack the different kinds and varieties of grain.

In the northern half of the United States stem rust overwinters on wild grasses and grain straw in the black, or teliospore, stage. The overwintered teliospores germinate in the spring, producing sporidia, or secondary spores, which infect the leaves of rust-susceptible barberries. These spores cannot infect grains and grasses. When the fungus becomes established on the barberry, the pycniospore, or sexual stage, appears on the upper surface of the leaf. In this stage, hybridization may take place between different races. Occasionally new races of the fungus are thus produced, which can attack varieties of grain previously considered resistant. The aeciospore, or cluster-cup, stage is produced on the under side of the infected barberry leaves. These spores infect nearby grains and grasses, on which the red urediospore, or repeating stage, of the fungus develops. Under favorable weather conditions several generations of red spores may develop on grains or grasses during a single season. Myriads of these spores are carried by the wind from plant to plant and from grainfield to grainfield throughout the growing season. As the infected grains and grasses mature, the black, or overwintering, spores develop, and the life cycle is completed.

In the South, the rust may overwinter on grains or grasses in the red, or repeating stage and spread north as the season advances. Rust from this source spreads to grainfields in the North somewhat later than that from the barberry, and under weather conditions favorable for rust development may cause widespread damage.

CONTROL

The United States Department of Agriculture is cooperating with State agencies in the eradication of rust-susceptible barberries to control the stem rust disease of small grains. The removal of these bushes eliminates early-spring sources of stem rust inoculum and destroys the plants on which races of the fungus breed. There are many species and varieties of barberries. Most of them are susceptible to stem rust, but a few are immune or highly resistant. This disease is controlled by the following methods:

1. *Use chemicals to destroy rust-susceptible barberries.*
 - (a) Apply common crushed rock salt around the crown of each barberry. About 10 pounds is needed to kill a 5-foot bush.
 - (b) Where the use of salt may endanger livestock or poultry, treat the crown of a 5-foot barberry with about 1 gallon of kerosene to kill the bush.
 - (c) Ammonium sulfamate or 2,4-dichlorophenoxyacetic acid (2,4-D) may be used to kill barberries. The canes are cut off at the crown and the freshly-cut surfaces treated with small amounts of chemical in concentrated form. Only experienced persons should use this method.
2. *Use approved rust-resistant varieties of grain.*
Plant breeders have produced varieties of small grains highly resistant to the common races of stem rust. Follow the recommendations of your State experiment station in the selection and planting of these varieties.
3. *Use approved cultural practices.*
On areas where stem rust is a serious problem, sow spring grain crops early and use early maturing varieties. Grain that matures early may escape serious damage from stem rust. Winter crops should be sown according to recommended seeding dates.

October 1948

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WHITE-FRINGED BEETLES

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WHITE-FRINGED BEETLES

(*Graphognathus* spp.)

Life History and Distribution

White-fringed beetle grubs live in the soil and feed on the roots of many kinds of plants, including beans, cotton, corn, peanuts, potatoes, various weeds, and ornamentals. They feed most heavily in the spring when nearly full grown and have ruined many acres of crops.

These insects pass the winter as grubs, or larvae. In the spring or early summer most of the grubs change to adults in little cells which they form in the soil. The grubs are white, legless, and about $\frac{1}{2}$ inch long when full grown. The adult beetles are about $\frac{1}{16}$ inch long. The adults normally emerge from the soil during the summer, and all of them are wingless females. They lay their eggs in small masses, usually attached to plant stems, sticks, or pebbles at or just below the soil surface. A single beetle may live 2 or 3 months and lay 600 to 700 eggs. The eggs hatch in about 2 weeks in warm, moist weather, and the grubs immediately enter the soil, where they remain until full grown. There is usually one generation a year.

There are three species and several races of white-fringed beetles, all of which are similar in appearance and habits. The beetle illustrated is *Graphognathus leucoloma striatus* (Buch.).

In 1948, 248,000 acres of land were known to be infested with the beetles. They are found in Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee.

Control

The Department of Agriculture is cooperating with State agencies in the control of these beetles and in the maintenance of quarantines to prevent their spread. The following measures are used in control:

Control of larvae by soil treatment.—Apply 10 pounds of DDT per acre uniformly to the soil surface as a dust (example, 200 pounds of a 5-percent DDT dust) by hand or with a mechanical distributor, or apply as a spray. Disk or cultivate immediately into the top 3 inches of soil.

Control of adults by foliage applications.—Spray yards, vacant lots, idle fields, shrubs, flowers, or other plants not used as food for man or animals with $\frac{1}{2}$ to 1 pound of DDT per acre in a water suspension or an emulsion. Apply the spray every 10 to 15 days throughout the beetle season. For a suspension spray use 2 pounds of a wettable powder containing 50 percent of DDT in 100 gallons of water, or, for small quantities, $\frac{1}{2}$ ounce of this powder in 1 gallon of water. DDT emulsions have greater residual value than suspensions. Ready-prepared emulsions are obtainable and should be used according to directions on the container.

In gardens, pastures, or on crops to be used as food, apply 8 to 10 pounds of cryolite in 100 gallons of water per acre at intervals of 7 to 10 days throughout the season.

Control by cultural practices.—Legume crops are favored by white-fringed beetles. Keep infestations low by the following practices:

1. Plant oats or other small grains in heavily infested fields.
2. Do not plant more than one-fourth of the cropland in annual legumes each year, and do not plant the same land to these crops more than once in 3 or 4 years.
3. Do not intercrop corn with peanuts, soybeans, crotalaria, or velvet-beans, and, insofar as possible, practice clean cultivation.
4. Fertilize corn or cotton heavily with commercial fertilizer or by turning under a winter cover crop.

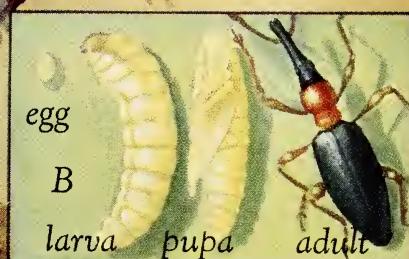
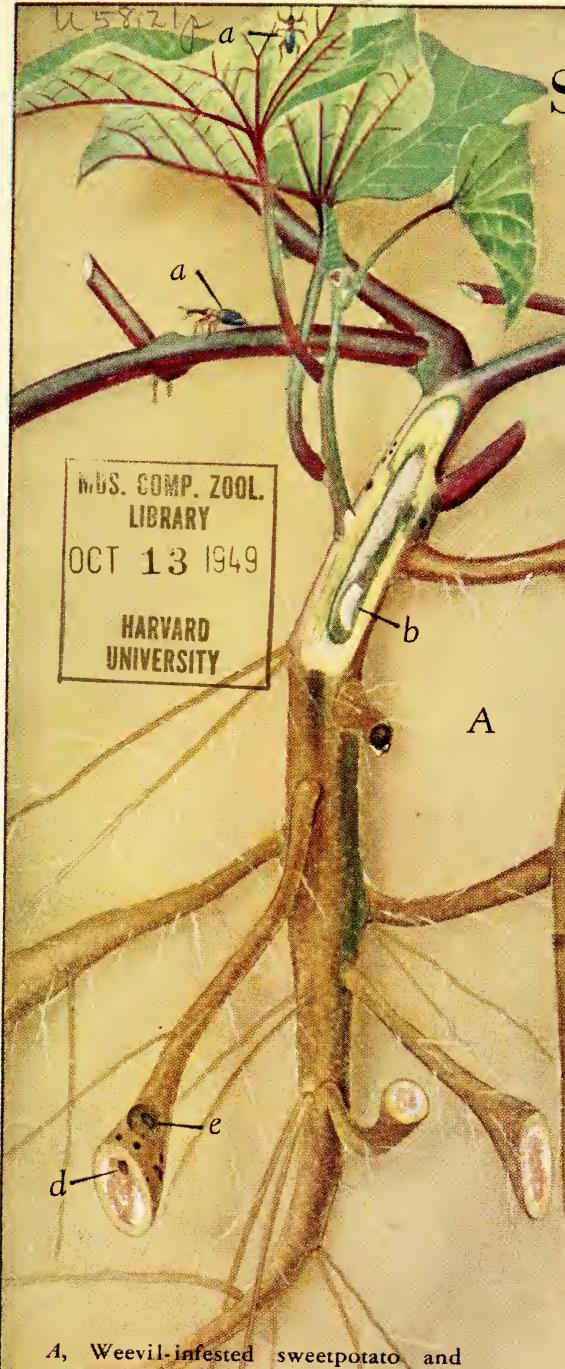
CAUTION.—Insecticides are poisonous and should be handled with care. Store in a dry place where children and animals will not have access to them.

July 1949

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SWEETPOTATO WEEVIL



A, Weevil-infested sweetpotato and crown of plant; *a*, adults; *b*, larvae; *c*, pupa; *d*, larval injury; *e*, exit holes; *f*, feeding and egg punctures. About natural size. B, Developmental stages about 5 times natural size.

(See other side for life history and control)

Picture Sheet No. 25

SWEETPOTATO WEEVIL

(*Cylas formicarius elegantulus* (Sum.))

Life History and Injury

The sweetpotato weevil is the most destructive insect pest attacking the sweetpotato crop. The adult weevil lays its eggs in small holes, which it punctures in the plant stems near the surface of the soil, or directly in the potatoes when it can reach them. In about a week the eggs hatch into small, white grubs, which feed and grow in the vines or in the potatoes. In 2 or 3 weeks the grub is fully grown and about three-eighths of an inch long. While in the stem or potato, the grub changes into the pupa, or resting stage, which is white and slightly smaller than the grub. After 7 or 8 days the adult weevil crawls out of its pupal skin and emerges from the sweetpotato plant to feed and mate. The females are then ready to lay eggs for another generation. The weevils are about one-fourth of an inch long and, because of their long legs and slim body, look like large ants. If the weather is favorable, the weevil may live for several months.

The adult weevils injure the sweetpotato plant by feeding on the leaves, vines, and roots, and the grubs by feeding within the stems, roots, and potatoes. Small holes in groups on the surface of the potatoes are either feeding marks or holes made by females in laying their eggs. Larger holes are made by newly developed weevils when they emerge from the sweetpotatoes. If weevily potatoes are cut open, the grub-made tunnels can be seen, often with grubs or pupae in them. Infested sweetpotatoes have a bitter taste and are unfit for food.

The weevil is known to exist in sections of Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas.

Prevention, Eradication, and Control

Most infestations of the sweetpotato weevil are established in new areas when sweetpotato plants, seed, or table potatoes are brought in from infested areas. Quarantines are maintained in the principal sweetpotato-growing States to prevent introduction of the weevil, and by States in which it is present to prevent further spread and to assist in its eradication and control. Most States maintaining quarantines permit entry of commercial sweetpotatoes from infested areas only when the stock has been fumigated with the prescribed dosage of methyl bromide. The United States Department of Agriculture is cooperating with the States in the control and prevention of spread of this weevil.

In areas where infestations are light the pest can be eradicated if it is deprived of its food for about one year. The procedures are as follows:

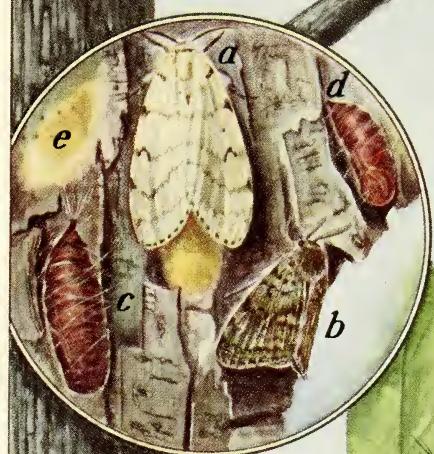
1. Plant no sweetpotatoes for one year in a zone extending $\frac{1}{2}$ to 1 mile from any known infestation.
2. On infested farms: (a) Dispose of all remaining sweetpotatoes by February 1 or earlier by dehydration, feeding to livestock, or burning. (b) Immediately after cleaning up the storage place, treat it with a DDT spray. Use either an emulsion concentrate or a wettable powder, diluted with water to contain the equivalent of $\frac{1}{2}$ pound of technical DDT in each $7\frac{1}{2}$ gallons of spray. Apply the spray to all surface areas, stopping before it begins to run off. (c) At harvesttime remove all sweetpotatoes from the field and do not store infested potatoes. Destroy all roots, crowns, small sweetpotatoes, scraps, and volunteer plants. Graze livestock on the field after harvest if possible. Plow old sweet-potato fields at least twice during the winter.

In commercial areas where fields are generally infested with the weevil, effective control may be had by the following practices:

1. Use State-certified seed sweetpotatoes. If seed is selected locally at harvesttime, treat it thoroughly with 10-percent DDT dust at the rate of 1 pound to 6 to 8 bushels of seed and store the seed away from any food products for man or animals.
2. Follow clean-up practices given for light infestations (2, b and c).
3. Destroy plants and tubers in seedbeds as soon as sufficient plants have been produced.
4. Rotate field plantings. Do not follow sweetpotatoes with sweetpotatoes. Plant the new crop as far as possible from the sweetpotato crop of the previous year.

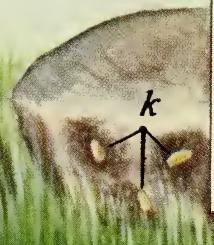
CAUTION. Do not let DDT sprays and dusts reach any food products for man or animals. DDT is poisonous and should be handled with care. Store it in a dry place where children and animals will not have access to it.

GYPSY MOTH



Close-up of *a*, ovipositing female; *b*, male; *c*, female pupa; *d*, male pupa; *e*, old egg mass. Larvae on oak leaf: *f*, first instar; *g*, second instar; *h*, fourth instar; *i*, sixth instar or mature larva. Egg masses, *k*, under branches and on rock; *l*, young larvae spinning down. *a* to *i* about natural size; *k* and *l* reduced. (See other side for life history and control.)

Picture Sheet No. 26



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THE GYPSY MOTH

(*Porthetria dispar* (L.))

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The gypsy moth is a serious pest of forest and shade trees in New England and eastern New York State. The caterpillars, or larvae, of these moths eat the leaves. The defoliation retards the growth and otherwise weakens the trees, and repeated complete defoliation will permanently injure or even kill them.

This moth was accidentally introduced into this country near Medford, Mass., in 1869. It spread rapidly through several of the Northeastern States. For many years the infested area has been under Federal quarantine. In part of this regulated area suppressive measures are being carried out in co-operation with State and local agencies.

The gypsy moth larvae usually appear about the first of May. They increase in size until by the middle of June they are 1½ to 2 inches long. They can then be recognized by several pairs of red and blue dots on their backs. Late in June or early in July they become mature and seek shady places, such as on trees or rocks, in which to pupate, or transform into moths. The moths emerge about a month later. The males are strong daytime fliers, but the females cannot fly and so lay their eggs close to the place where they issued as moths. The eggs are laid in clusters of 400 or more, which are covered with brownish hairs. The winter is passed in the egg stage.

Control

The gypsy moth can be controlled most effectively with DDT. An oil solution or an emulsion containing this insecticide is applied as a spray while the insect is in the caterpillar stage. Large forested areas are usually sprayed from aircraft. For use along highways and residential areas either mist blowers or hydraulic sprayers are suitable, and for treating low growth along stone walls and fences sprayers of the knapsack type can be employed. Early in the season the spray should be applied at the rate of 1 pound of actual DDT per acre, but after the foliage has developed ¾ pound per acre is sufficient. Information on formulations and dilutions to use with each type of equipment may be obtained from the Division of Gypsy Moth Control, Bureau of Entomology and Plant Quarantine, Greenfield, Mass.

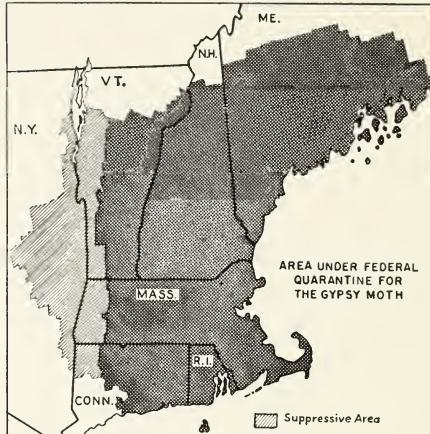
CAUTION.—DDT is poisonous and should be handled with care. Store in a dry place where children and animals will not have access to it.

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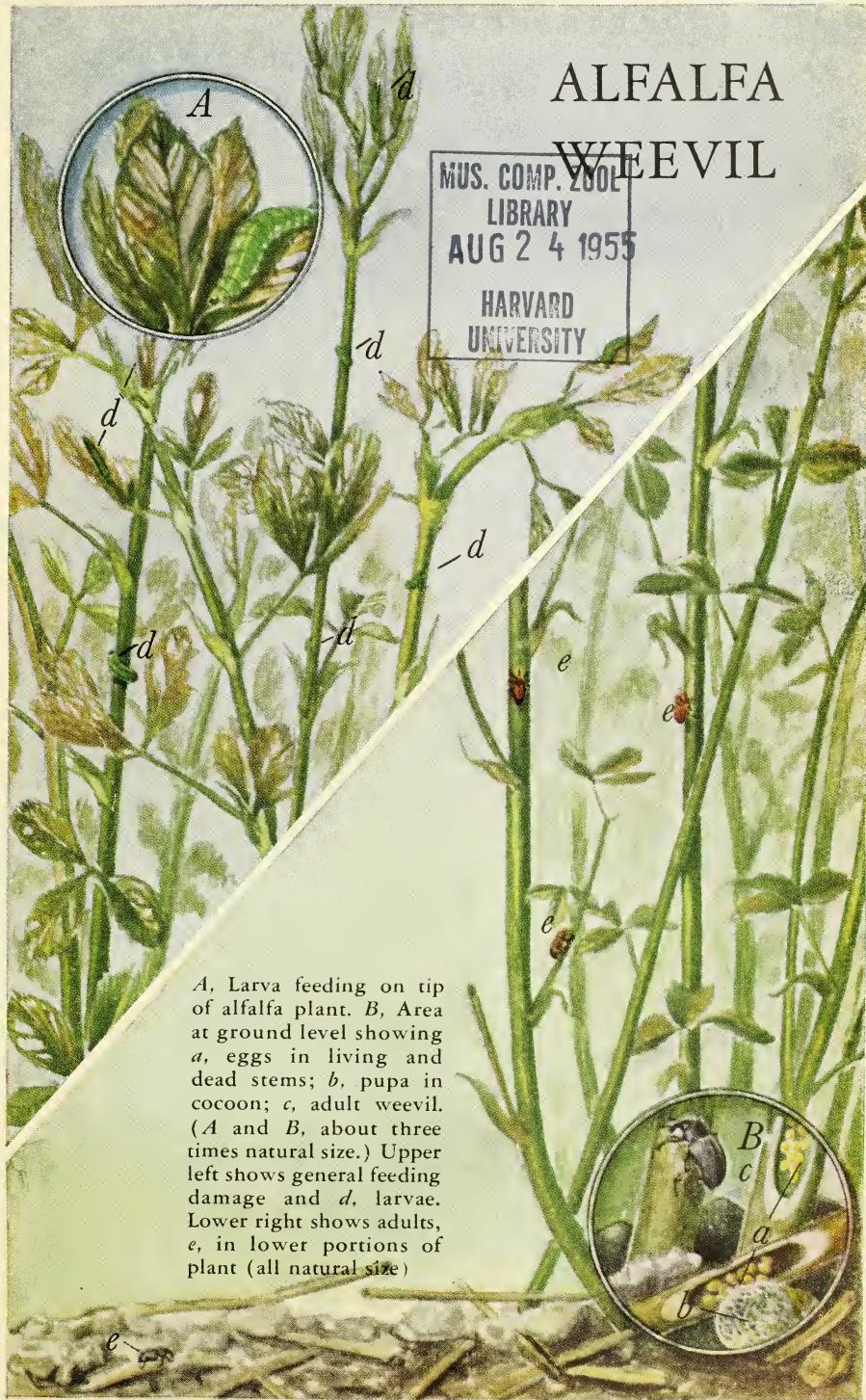
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AGRICULTURAL RESEARCH SERVICE

ENTOMOLOGY RESEARCH BRANCH



Picture Sheet No. 28

See other side for information on alfalfa weevil development and on control.

THE ALFALFA WEEVIL

(*Hypera postica*)

Larvae of the alfalfa weevil feed on the tips, leaves, and buds of alfalfa, and are particularly damaging to the first crop. After the first crop of alfalfa is cut, the larvae and adults feed heavily on the new shoots of the second crop. They can destroy the feed value of a hay crop, or prevent the profitable production of seed.

This insect occurs in Maryland, Delaware, New Jersey, Pennsylvania, Virginia, and West Virginia; in Nebraska and South Dakota; and in most Western States.

DEVELOPMENT

In most areas only one generation occurs in a growing season. The female weevils lay most of their eggs in March, April, and May. In warm weather the eggs hatch in 1 to 2 weeks. Larvae are most abundant from mid-April to early June, when the first alfalfa crop is approaching the bud stage. They feed 3 to 4 weeks. When full grown, larvae spin cocoons on or near the plants, and pupate 1 to 2 weeks. The adults, which emerge from the cocoons, mate in the fall or spring. They overwinter in or near alfalfa fields.

CONTROL . . . Eastern States

For best control, spray alfalfa in mid-April when the plants are 6 to 10 inches high. Apply heptachlor at the rate of 4 ounces per acre to destroy the small larvae.

CAUTION.—After treating the alfalfa, wait 7 days before cutting the crop or allowing livestock to graze on it.

CONTROL . . . Western States

Alfalfa for Seed.—Best control is obtained by an early-season chemical treatment that kills adult weevils before they lay many eggs. A single application of insecticide is made when the spring growth is $\frac{1}{2}$ inch to 2 inches high. If you spray, apply heptachlor or dieldrin at the rate of 4 ounces per acre. If you dust, apply heptachlor at the rate of 5 ounces per acre.

CAUTION.—After applying heptachlor at the 4-ounce-per-acre rate, wait 7 days before cutting the treated alfalfa or allowing livestock to graze on it; after applying at the 5-ounce-

per-acre rate, wait 10 days. After applying dieldrin, do not allow livestock to graze on the treated alfalfa until after the first cutting.

Any alfalfa weevil larvae that may be present on first-growth alfalfa left for seed will be destroyed by the insecticide used to control lygus bugs. DDT is applied when the plants are in the bud stage. Generally, it is applied at the rate of 2 pounds per acre in a spray or 3 pounds per acre in a dust.

CAUTION.—Do not feed DDT-treated alfalfa to dairy animals, animals being fattened for slaughter, or poultry.

Alfalfa for Hay.—Early-season chemical treatment to kill the adults, as described for seed crops, is the best control.

If you wait until May or June to start control measures, apply an insecticide to kill the larvae as soon as they are numerous on the plants. Spray or dust with one of the following insecticides at the per-acre rate indicated: Methoxychlor, 2 pounds; parathion, 4 ounces; aldrin, 2 ounces; lindane, 2 ounces; heptachlor, $\frac{3}{4}$ ounce.

CAUTION.—Do not allow animals to feed on alfalfa for 15 days after applying parathion, aldrin, or lindane, or for 3 days after applying heptachlor.

THE SPRAY OR DUST

To prepare a spray, buy an emulsifiable concentrate of the required insecticide and mix it with water. Use the amount of the concentrate necessary to obtain the recommended dosage. If you use a ground sprayer, you will need at least 6 gallons of spray per acre. If the application is made with an airplane, as little as 2 gallons of spray per acre can be used.

For dusting, use any strength of readymade dust sold in your area. Apply the amount necessary to obtain the recommended dosage.

CAUTION.—Most insecticides are poisons. Store insecticides where children and animals cannot reach them. Follow the directions for handling. Heed all warnings on the container label.

Parathion is particularly dangerous. It should be applied with power machines only. When handling it wear a gas mask or respirator of a type recommended by the U. S. Department of Agriculture.